SCIENTIFIC AMERICAN SUPPLEMENT No. 800

Scientific American Supplement, Vol. XXXI. No. 800.
Scientific American, established 1845.

NEW YORK, MAY 2, 1891.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

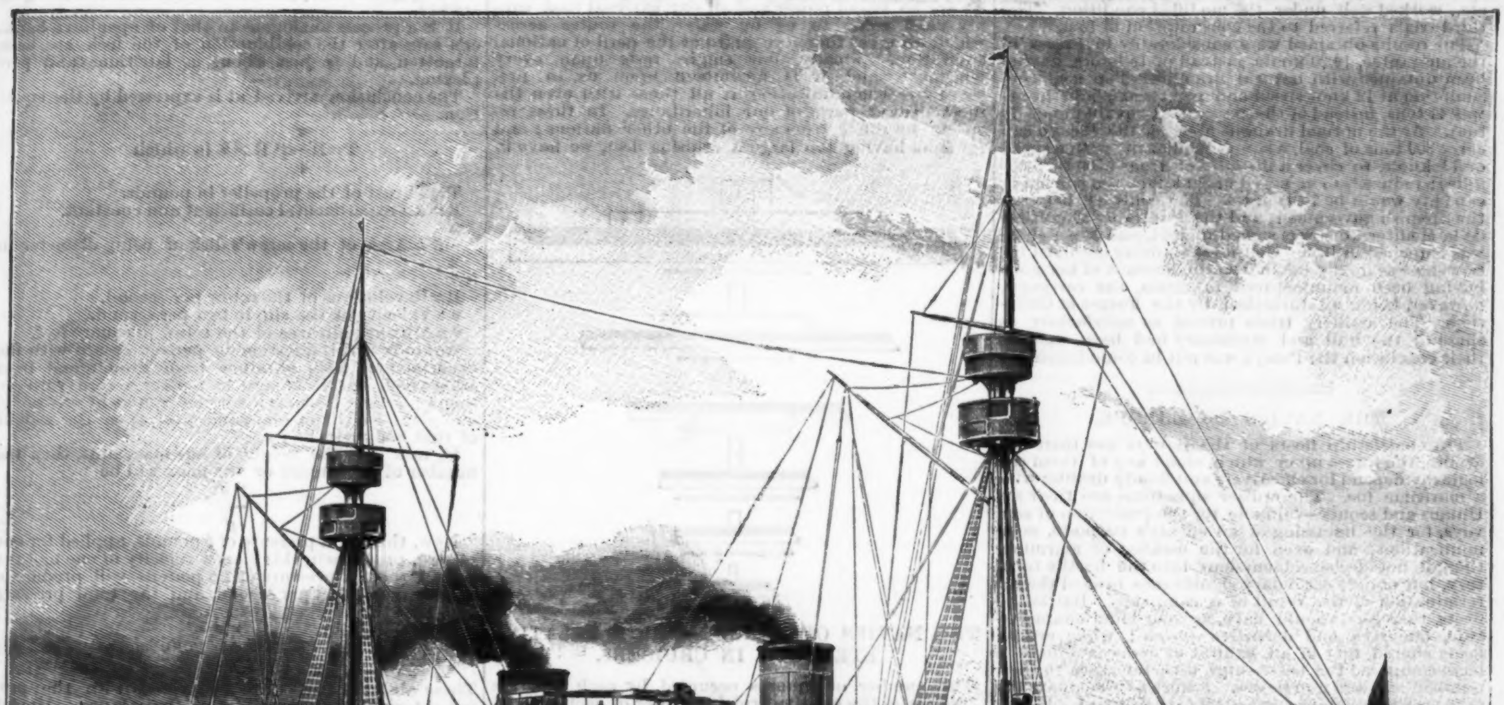
THE SPANISH CRUISER PELAYO.

THE first class cruiser Pelayo, herewith illustrated, which has recently been added to the fleet of Spain, was constructed by the Compagnie des Forges et Chantiers at their works of La Seyne, near Toulon. All the plans for the hull of this ship were prepared under the direction of M. Lagane, director of the La Seyne Works, and the engines were designed by M. Orsel, chief of the Mepenti Works. The following are some of the leading dimensions of the vessel:

Extreme length	346 ft. 5½ in.
Width at water line	66 " 3 "
Depth of hull amidships	24 " 1¼ "
Draught of water, aft	24 " 9¾ "
Displacement	9,900 tons.
Indicated horse power with natural draught	6,800
Speed obtained during trials (natural draught)	15 knots.

rounded with casings 39 in. in height and 11·8 in. thick.

Below the armored deck the hull is divided into numerous compartments, the most important of which is the double bottom that extends for nearly the whole length of the ship; it consists of an inner plating of steel, riveted to the framing, which divides it into 98 water-tight cells. Above this double bottom the space is separated into compartments by 16 water-tight transverse bulkheads; besides these, in the engine and boiler rooms, as well as in the ammunition stores, a longitudinal bulkhead extending as high as the armored deck completes the subdivision. In all there are no fewer than 145 compartments in the ship, so that the destructive effects of attack from torpedoes or projectiles ought to be entirely local. All of the compartments, including those in the double bottom, can be emptied by means of a collecting channel about 12 in. in diameter running from end to end of the ship, and connected to two pumps, each of which has a (12·60 in.), mounted, one forward and the other aft, in two Canet barbette turrets. (c) Two Hontoria guns of 28 centimeters (11·02 in.) on Canet mountings, and placed almost amidship, one on each side. (d) One Hontoria gun of 16 centimeters (6·29 in.) placed quite forward and available only for chase firing. (e) Twelve Hontoria guns of 12 centimeters (4·72 in.) placed six on each side in batteries, and mounted on Canet carriages. (f) A large number of quick-firing guns and revolving cannon, distributed over the decks, in the double tops of the military masts and other places. (g) Seven torpedo-firing tubes on the lower deck above the armored deck. The barbette turrets, in which the 32 centimeter guns are placed, are protected with steel plates 15·75 in. thick; the turrets are supported on a framing also protected with steel plates 7·87 in. thick, extending down to the steel deck, and serving as a protected passage for the ammunition hoists. The forward turret for the 32 centimeter gun is placed at such a height that the axis of the



THE SPANISH CRUISER PELAYO.

The Pelayo is constructed of steel throughout, and all the metal employed, which was made in France was subjected to the same tests as those prescribed by the French Navy Department. Says *Engineering*, to which we are also indebted for our engraving: The lines of the ship are finer than is usually the case with vessels of this class; the spur has only a moderate projection, and the stern overhangs sufficiently to afford considerable protection to the rudder post. The draught of water was limited to 24 ft. 9 in. when the ship is fully ar ed and equipped, in order that she might pass through the Suez Canal. From end to end of the hull, above the water line, is a steel belt of armor; this belt is made up of a single row of plates 6 ft. 10 in. high, the thickness in the center being 17·70 in. and at the ends 11·81 in. The protection of the vital parts of the ship is supplemented by a steel deck placed at the level of the top of the armor plates. All the openin s made in this deck are sur- discharge capacity of 500 tons an hour; various other pumps can also, in case of emergency, be employed to drain any of the compartments. The coal bunkers, which have a capacity of about 800 tons, are arranged on each side of the stokeholds, and so constitute an auxiliary protection to the armor plate and the compartments under the water line. The dead works above the steel deck comprise two upper decks, the intermediate spaces being very commodious and affording ample accommodation for the officers and crew. On the upper or battery deck are arranged the apartments of the admiral, the superior officers, and two hospitals; on the intermediate deck are the quarters of the subordinate officers and engineers. The seamen's quarters are also very commodious, and the ship affords ample space for 600 men.

The armament of the Pelayo is as follows: (a) A heavy steel spur which forms a part of the framing of the ship. (b) Two Hontoria guns of 32 centimeters gun is 31 ft. 2 in. above the water line, and is so mounted that it has an angle of 250 deg. On account of the relatively great height above the water, this gun can be fired in any kind of sea. The rear gun, also 32 centimeters, has a total firing angle of 220 deg. The broadside guns of 28 centimeters can each fire through an angle of 180 deg., or parallel in each direction with the keel of the vessel; they are thus equally available in chasing or retreating. By this arrangement, three heavy guns are always available in each direction, and three for broadside firing. A shelter heavily shielded on the upper deck is very completely fitted up with telegraphic, telephonic, and other transmitting apparatus, as well as with a duplicate steering gear, so that the captain can fight his ship under the best conditions, and in comparative security. The ammunition stores are arranged in three groups, each corresponding to the turrets they are intended to supply; they are, of course, completely equipped with

rails and carriers for transporting projectiles and cartridges. The sail area of the Pelayo is less than 6,000 square feet; she has two military masts of steel, with the few spars necessary for carrying the canvas and making signals; the tops of the masts are arranged for machine guns.

The engine power of the Pelayo is as follows: 1. Two independent sets of main engines, each driving a propeller, and each consisting of a pair of compound condensing engines, so coupled that they can be worked together or separately. 2. Two sets of auxiliary engines which drive the circulating and condensing pumps. 3. Twelve return flue boilers, registered for a working pressure of 82 lb. per square inch; these boilers are divided into groups of three, placed in separate chambers. The stokeholds are ventilated by four large fans, which can, in case of necessity, be employed to create a forced draught.

In addition to the main machinery there are a number of smaller engines for miscellaneous purposes. The more important of these are a servo-motor placed under the armed deck of the ship within reach of the captain's shelter, and connected with the large servo-motor which is placed aft, and which drives the steering gear; an engine coupled to the large capstan, two rotary steam pumps, each capable of lifting 500 tons of water an hour; a smaller pump, with a capacity of 30 tons an hour, various steam winches, the electric light plant, pumps for feeding the boilers, etc.

The official trials of the machinery were divided into three series. The first referred to the speed obtained with natural draught, and with the hatches of the stokeholds remaining open. A minimum speed of 15 knots was guaranteed, this speed to be the general mean of four runs on a course of 6·712 knots. The second trials were with a moderately accelerated draught; in these the pressure of air forced into the stokeholds was not to exceed 30 millimeters of water, and the object of the trial was not to ascertain what increase of speed could be obtained, but that all the machinery, etc., worked well under the modified condition. The third trials referred to the consumption of fuel.

The results obtained were considerably in excess of the guarantee, 16·20 knots, instead of 15 knots, having been obtained with natural draught. The coal consumption at 12 knot speed and per twenty-four hours was 45 tons, instead of the prescribed maximum of 70 tons. At the normal draught of water the Pelayo can carry 800 tons of coal, a supply sufficient, with a speed of 12 knots, to cover a distance of from 4,500 to 5,000 miles; reduced to a speed of 10 knots, the steaming capacity would be 7,500 miles. The contract between the Spanish government and the Forges et Chantiers de la Mediterranee was signed in 1884, and the Pelayo was launched in 1888. Considerable delay occurred before she was finally taken over, on account of her guns having been manufactured in Spain, the carriages, however, being all furnished by the Forges et Chantiers. The artillery trials proved as satisfactory as those of the hull and machinery had been, and on their conclusion the Pelayo was put in commission.

THE NAVIES OF EUROPE.

THE battleship fleets of the powers are their sea armies, the forces upon which alone any of them can logically depend for effectively and finally dealing with a maritime foe. The cruiser squadrons are their sea Uhlans and scouts—valuable for the protection of convoys, for the harassing of an enemy's outposts, communications, and even for the making of alarming, though not decisive, incursions into the hostile territory, but of only secondary significance toward the determination of the result of a campaign. Battleship fleets, therefore, should have, as their chief characteristic, offensive and defensive power; while cruiser fleets should, first of all, exhibit extreme mobility. I have compared the battleships with reference to their number, size and gun power. I must now compare the cruisers with reference primarily to their speed. It may be convenient, however, if, before doing so, I show how many cruisers (of each of the three classes into which the Navy List divides our own vessels of this type) the six powers severally will possess by the year 1894, when all the current programmes of construction will have been completed. Our cruisers, it should be explained, are in the Navy List classified, not according to their speed, but according to their size, and their offensive and defensive power, those of the first class, with few exceptions, having vertical armor on their sides, and thus forming a kind of connecting link between the heavily armored battleships and the light cruisers, which, if they carry armor at all, have it only in the shape of a protective deck at or about the level of the water line. The summary is as follows:

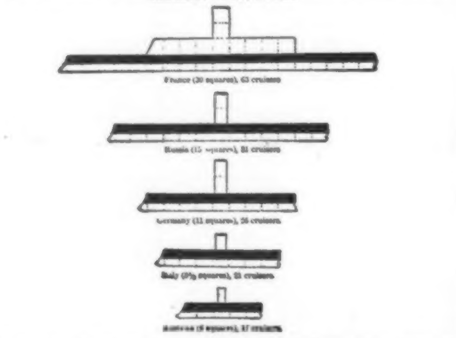
	1st Class. No.	1st Class. Tonnage.	2d Class. No.	2d Class. Tonnage.	3d Class. No.	3d Class. Tonnage.
Great Britain......	23	162,200	48	178,540	54	114,545
France............	12	65,584	16	64,830	35	64,835
Italy	—	—	7	23,680	14	30,274
Russia............	8	53,230	9	29,400	14	29,650
Germany............	1	5,200	6	24,640	19	40,120
Austria..........	3	11,800	2	6,760	12	21,630

The first class is composed of cruisers armored, or of upward of 7,000 tons displacement; the second class of vessels of from 3,000 to 7,000 tons; and the third of vessels of between 3,000 and about 1,300 tons. Each country has, besides, a number of sloops and gun vessels, but these are crafts which, as the tale of them could be increased at very short notice, and as they are, as a rule, little suited either for fighting or for running away, need not here be taken into consideration. The cruiser fleets proper, as I have summarized them, are, then, thus divided: Great Britain, 125 ships (of which twelve are armored on the sides), averaging 3,642 tons apiece; France, sixty-three ships (of which twelve are armored on the sides), averaging 3,099 tons apiece; Italy, twenty-one ships, of which none have side armor), averaging 2,569 tons apiece; Russia, thirty-one ships (of which eight are armored on the sides), averaging 3,623 tons apiece; Germany, twenty-six ships (of which one is armored on the sides), averaging 2,690 tons apiece; and Austria, seventeen ships (of which three are armored on the sides), averaging 2,363 tons apiece. Having thus cleared the way, I may examine the relative values of the cruiser fleets from the point of view of their mobility—namely, of the speed of the vessels composing them. For this purpose I accept the estimated extreme speed or the trial speed of each craft. We may take it that, continuously steaming, each ship will do from three to five knots less.

	Above 20 knots	18 to 20 knots	16 to 18 knots	14 to 16 knots	12 to 14 knots	Under 12 knots
Great Britain.......	2	61	30	6	26	—
France..............	—	7	20	23	13	—
Italy	2	5	5	6	—	3
Russia	2	2	1	6	10	10
Germany..........	1	5	—	10	10	—
Austria....	—	6	1	1	4	5

From this table it will appear that out of 150 cruisers having a nominal extreme speed of sixteen knots and over, Great Britain possesses, or will possess by 1894, ninety-three, as compared with fifty-seven possessed by the remaining five powers; and that, in fact, the majority of the cruisers owned by the other powers are slow craft, while the majority of hers are fast. It may be accepted, moreover, that most of the slow cruisers are old and comparatively valueless, while nearly all the fast ones are modern and armed with modern weapons, besides having a relatively wider radius of action. Multiplying the number of vessels of each degree of speed by their average speed in knots, and also by their average tonnage, is a process that gives us a fair idea of the aggregate cruiser strength of each nation. It is by such a process that materials have been obtained for the compilation of the six diagrams given herewith, which show the comparative cruiser force of the six powers.

Practically, the cruiser force of Great Britain is a little superior to that of the five remaining powers combined; but lest it be supposed by any that we have more cruisers than we need, it may be well to add that the duties which in time of war would be imposed upon our cruisers are immeasurably greater in every respect than the duties which would be imposed on those of all the other powers combined. For example, Great Britain and her colonies own, and have to protect, 13,000 merchant vessels, while France, Italy, Russia, Germany, and Austria together own only 6,600. Again we are an island power and all our external food supply must come to us by water, the routes across which we must therefore guard at the peril of national starvation. Finally, our empire rests upon every continent, and it is incumbent upon us to preserve free communication at all times with even the most distant parts of our inheritance. In these respects we differ from any of the other nations; and far from having too large a cruising fleet, we have in fact altogether too small a one. This, I think, is easily demonstrable. We have, roughly speaking, 455,000 tons of cruisers to insure nearly 11,000,000 tons of merchant shipping. France, roughly speaking, has 195,000 tons of cruisers to insure only 985,000 tons of merchant shipping. If we had cruisers in proportion to those of France, we should have, not 455,000, but over 2,000,000 tons of them, or say 650 ships instead of our 125.



THE NAVIES OF EUROPE—THEIR RELATIVE STRENGTH IN CRUISERS.

(The number of squares occupied by each diagram indicates the relative cruising power of each navy.)

Besides the vessels which have been taken into account in the above estimates, each of the powers possesses a certain number of troopships, transports, storeships and yachts. These, as being non-fighting craft, do not properly form part of the various navies. There are also the small craft and a few miscellaneous vessels which do not lend themselves to classification, such as our torpedo ram Polyphemus, the torpedo depot ships, and the floating battery which has been adopted for stationary defense by Italy. There are, finally, the numerous coast defense vessels and the torpedo flotillas. These two last classes, taken together, will form the subject of my next letter.—*Daily Graphic.*

THE PHYSICS OF THE SCREW PROPELLER.

By JOHN LOWE, Chief Engineer U. S. Navy.

IT is a notable fact that in nearly every case of invention or discovery of permanent value to mankind, they have been introduced and made use of long before the physical laws under which they operate have been understood.

Most strikingly has this been the case with the screw propeller, for notwithstanding the many years it has been in use, and the splendid success it has met with, it is a fact that at this day the physical laws governing and limiting its operation are not yet understood.

Indeed, if search be made throughout the vast mass of literature which has been written upon this subject, there cannot be found as a culmination any rule or formula which can connect the dimensions, the velocity and the result in any satisfactory manner, nor has any of it proved of any practical value, save and excepting that written by Isherwood and by Froude in detailing their experiments; and saving these experiments, all our knowledge has been obtained an item at a time, by costly attempt and failure.

Thus, for example, take the celebrated case of the old fashioned line of battle ship converted into a screw steamer, in which, whether the engines went one way or the other, the vessel always went astern, proving among other things that under proper conditions the screw will have neither thrust nor slip, but will act simply as a centrifugal pump.

In view of these facts, it is with considerable trepidation that the claim is hereby made for this paper that it declares and demonstrates, for the first time, the relations which must and which do exist between the thrust, the slip, the dimensions and the situation of the screw, when acting as a propeller.

There is a limiting set of conditions reached, depending upon the velocity, when a screw will cease to act solely as a propeller, but will commence to act also as a centrifugal pump, when the water is discharged both radially and axially.

These conditions are not considered in this paper, but the subject is limited to that of the screw when acting as a propeller.

The method of investigation pursued was first to discard and dismiss from the mind all previous knowledge of the subject, and thus to prepare the mind for the reception, not of the metaphysics, but of the physics of the screw propeller.

For this purpose, sixteen good examples of screws of all sizes were selected, in which the data observed and recorded were of a reliable character.

Now, then, one single assumption was made, to wit, that the thrust is some function of the slip, the dimensions, the velocity, and the situation of the screw.

The question then arose—which function? The answer was obtained by trying all possible functions of all the elements until such functions and a constant were found, which connected all the data, thereby making a direct appeal to nature and obtaining an answer.

It is a process analogous to that of opening a banker's safe after the combination of the lock has been forgotten, and is just about as laborious and perplexing.

The conclusion arrived at is expressed by the equation

$$T = K\frac{\pi}{4}d^2\,R\,v^2\,\theta \text{ in which}$$

T = Thrust of the propeller in pounds.
K = An experimental coefficient and constant.
$\frac{\pi}{4}d^2$ = Area of the screw's disk, d being diameter in feet.
R = Revolutions of the screw per second.
v = Velocity of the slip in feet per second.
θ = Athwartship area of the screw in square feet.

Not only is this question in perfect accord with the experimental facts obtained from Froude and from Isherwood, but it is also in perfect accord with abstract physics; because if v is the volume of any body, and γ the weight of one cubic unit, then the weight of that body will be γv.

If, now, g is the weight of one mass unit, then the number of such units or the mass will be

$$\frac{\gamma v}{g}$$

Now, then, if a pressure of t pounds, applied for one second, produces in this mass a velocity of one foot per second, then a pressure of $t\,v$ pounds will produce a a velocity of v feet per second, and the total pressure will be

$$T = t\,v\,\frac{\gamma\,v}{g} \text{ pounds.}$$

These abstract truths are connected with the proposed formula by contemplating the minutest element of which θ is composed; it is a simple radial line, which in one revolution will sweep the area

$$\frac{\pi}{4}d^2;$$

and the area of

$$R\frac{\pi}{4}d^2$$

per second; meanwhile setting in motion the water thus swept with the velocity of v feet per second.

In short, a cylinder v feet thick and of an area

$$\frac{\pi}{4}d^2\,R$$

is the volume of water set in motion by this line in one second. Now, each and every line composing θ does the same thing, and, therefore, the total quantity of water which is set in motion in one second is

$$R\frac{\pi}{4}d^2\,v\,\theta;$$

of which, as previously explained, the mass is

$$\frac{\gamma\,R\,\pi}{g\,4}d^2\,v\,\theta;$$

and the thrust is

$$T = \frac{t\,\gamma}{g}\,\frac{\pi}{4}\,d^2\,R\,v^2\,\theta;$$

demonstrating the formula.

Now, if this quantity set in motion operated in vacuo, it would be easy to get the value of t from our text books; but the water in question moves in, and is resisted by, other water; and thus the value of t must be found experimentally. The consolidated constant

$$K = \frac{t\,\gamma}{g}$$

is taken provisionally from the example of the U. S. steamer Dolphin, and found to be

$$K = 0{\cdot}22135. \quad \text{Log } K = \bar{1}{\cdot}3450829.$$

We have then demonstrated the formula to be

$$T = K R \pi \frac{d^2}{4} v^2 \theta$$

and that it expresses the relations existing between all the elements of the screw propeller.

Not only is this the case, but as a corollary it is to be proved that by its use the screw propeller becomes a correct instrument for the measurement of the speed of the vessel in all ordinary cases.

Because Isherwood has shown how the thrust of the screw may be obtained from the performance of the engines; therefore, T may be regarded as a known quantity, and the equation may be solved for v.

The pitch of the screw being P, its usual speed is R P, and the speed of the ship is $S = (R P - v)$ in feet per second, which may be reduced to knots per hour.

Now, all this is true or it is untrue, and practice is the crucible to try it by. For this purpose the following table exhibits a comparison between experimental and calculated quantities, and is intended, without comment, to settle the question:

Name of Vessel.	Observed Quantities.							Calculated Quantities.	
	Diameter of the Screw.	Revolutions per Minute.	Pitch.	Athwartships Area	Thrust.	Slip of the Screw.	Speed of the Ship.	Slip of the Screw.	Speed of the Ship.
	ft.		ft.	ft.	lb.	per ct	knots	per ct	knots
Trenton	19·5	53	26·5	84·77	43613	10·22	12·61	12·40	12·636
Newark......	14·5	127	18·97	40	58757	20·3	19	10·98	20·917
Dolphin.	14·25	....	24·08	48·56	30534	12·77	15·38	12·77	15·38
S'n Francisco	13·5	124·8	18·75	44·55	67551	15·45	20·604	12	20·456
Concord......	10·5	153·34	13·02	21·45	27092	......	16·8	15·42	16·062
Siesta..	4·58	221·5	8	6·59	2093	23	13·45	16·43	14·58

The object of this paper is accomplished above, and the paper should now close. There are, however, one or two words left to be said upon the general subject.

It will be remembered by all who have measured propellers that no two points upon any blade are of the same pitch, and that the pitch assigned to any propeller is a mere nominal figure expressing the mean of all the observed pitches. Bearing this in mind, let us recall the remarkable example of the Iris, a vessel which was at first considerably over-screwed, and which, in consequence, upon trial, disappointed expectations as to speed. It will be remembered that afterward the screws of this vessel were reduced nearly one-half, and the expected speed was then much more than realized.

It will also be remembered that Mr. Wright's comment upon these performances was that nothing in the theory which required a balance between friction and slip could account for the difference in the performances of these screws.

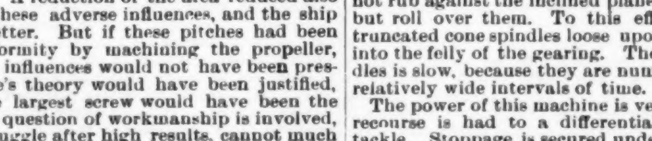
My own opinion, briefly expressed, is this: That the great difference between all the pitches was the cause of the discrepancy. The inferior pitches actually operated adversely. A reduction of the area reduced also the amount of these adverse influences, and the ship then behaved better. But if these pitches had been reduced to uniformity by machining the propeller, then the adverse influences would not have been present. Mr. Froude's theory would have been justified, and possibly the largest screw would have been the best; in short, a question of workmanship is involved, which, in the struggle after high results, cannot much longer be ignored.

At any rate, the cause of the vast amount of power absorbed by the largest screw has not been otherwise explained, and if the difference in pitches is not the cause, then the question arises: What is the cause?

THE RAVELLI HELICOIDAL WINDLASS.

MR. RAVELLI has undertaken to modify the ordinary arrangements adopted for endless screw gearings with a view of extending the applications of them to cases in which the non-reciprocity of the gearing constitutes an essential advantage. It is with this object in view that he employs helices of close pitch, at the risk of increasing the loss of work due to friction.

In the annex of class 52 of the Universal Exposition, there was exhibited a windlass of the capstan type, which was very powerful and served as a demonstration of Mr. Ravelli's system.



RAVELLI'S HELICOIDAL WINDLASS.

Our engraving gives a perspective view of this apparatus, which consists simply of a strong iron frame, of a bevel gearing, whose pinion is keyed to the winch shaft, and of a pair of helicoidal gearings. Upon the shaft that connects the two bevel wheels is keyed a drum provided with depressions for the reception of the chain to which the load to be lifted is attached.

The endless screw has several threads, but the latter do not, as usual, run around the entire circumference. If there are four threads, each of them embraces but a quarter, and if there are six, each embraces but a sixth. Upon the whole, this endless screw constitutes a sort of a disk upon the circumference of which are arranged a variable number of pins that are slightly inclined with respect to the bases of the disk. At every fraction of a revolution corresponding to the number of the pins one of them abandons the tooth of the gearing while the following pin and tooth engage.

In order to diminish passive resistances, the teeth do not rub against the inclined planes formed by the pins, but roll over them. To this effect, they consist of truncated cone spindles loose upon journals set firmly into the felly of the gearing. The wear of these spindles is slow, because they are numerous and engage at relatively wide intervals of time.

The power of this machine is very great, although no recourse is had to a differential mechanism nor to tackle. Stoppage is secured under full load, either in the raising or lowering of weights, without the intervention of any stop-work or brake. No flying back of the winch is to be feared, and this gives every security to the workman.

Mr. Ravelli has devised a certain number of variants of these gearings especially for models of small dimensions. If it is necessary to transmit motion in several directions, it is possible, owing to the wide diameter of the helix disk, to arrange bevel gearings in proper positions upon its circumference.—*Revue Industrielle.*

AN IMPROVED CIRCULAR STONE SAW.

THE mechanical sawing of stones, and particularly of hard stones and marbles, is, in various ways, the object of interesting studies. A perfect solution of this question is a thing to be desired by a large number of manufacturers who long to do away with work by hand. The rendering of the latter, when it is a question of hard stones, is, as well known, exceedingly small; besides, the use of grinding substances, such as sand, emery, etc., introduced with water into the groove made by the saw, presents several inconveniences, for they are in great part carried along by the water, and what is left attacks not only the stone but the saw itself, which is thus quickly put out of service.

Among the tentatives made in view of substituting for the ordinary saw a suitable blade adapted for mechanical work, it is necessary to hold before all to the method which consists in providing the teeth with diamonds. Up to the present the results obtained in this direction have not been very satisfactory. This is due less to the efficiency of the process than to the means employed for realizing it. The setting of the diamond has always left something to be desired from the standpoint of solidity. So, in blades having an alternating motion that have been provided therewith, a loosening of the diamond soon occurred, followed by its complete extraction.

FIG. 1.

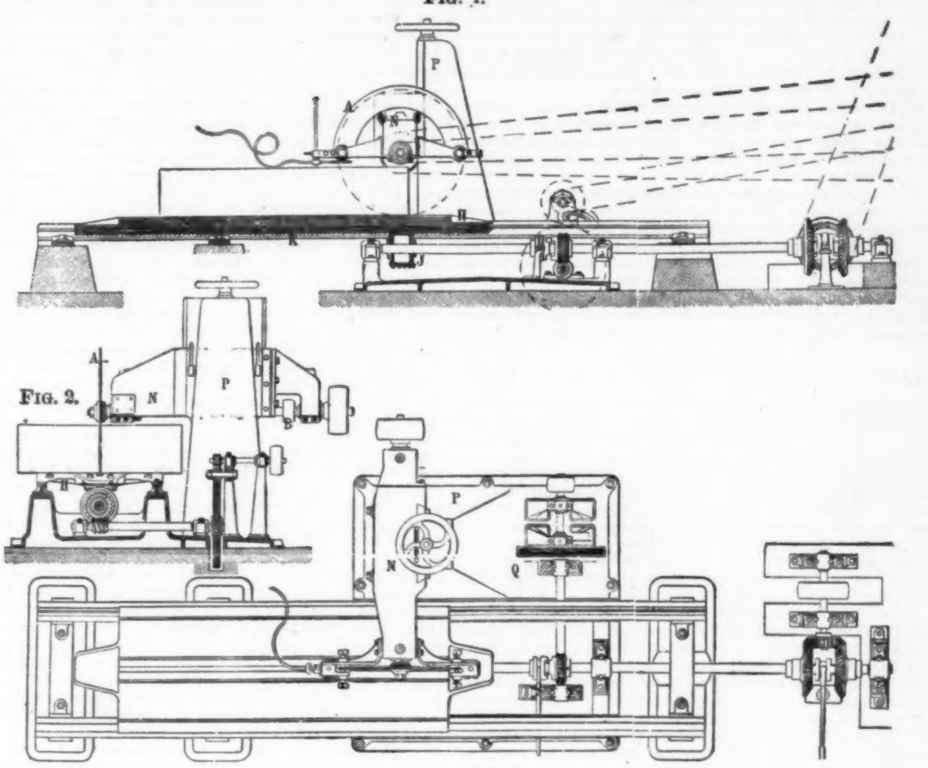


FIG. 2.

FIG. 3.

CIRCULAR STONE SAW.

FIG. 1.—Elevation. FIG. 2.—Transverse Section. FIG. 3.—Plan.

Although the selection of a blade is of great importance, an advantageous arrangement of the machine is also an important factor in the quality and production of the work.

It has hitherto been desired to exaggerate the simplicity of the mechanism, so that there has been devised a machine as a whole of too primitive a construction, which required expensive maneuvers to bring the blocks under the saw, and which did not permit of obtaining varied sawings cheaply.

Messrs. D'Espine Achard & Co. have taken up the study of this important problem. The experience that they have acquired upon this subject, and long researches followed by numerous trials, have led them to devise and have patented some types of stone-sawing machines which satisfy the following desiderata recognized as necessary in practice.

These machines permit of sawing blocks of large dimensions, with a forward motion of the saw from twenty to fifty times more rapid than with the old sand processes, and without requiring long and expensive maneuvers. The surfaces cut are smooth and polished, and the block may be easily cut in all directions, and this, in many cases, does away with the ulterior aid of the stone cutter. Finally, the diamonds of the teeth act always in the same direction, and consequently are not subject to shocks in their sockets.

In the figures that accompany this article we represent a small model of this sawing machine, which, like the larger models, is based upon the use of a circular saw, whose periphery is armed with small diamonds which constitute the toothing, and the process of setting of which has been patented by Mr. Kohler. The following is a succinct description of it. A small bar of soft steel is taken, and after it has been bent into the form of a very narrow U, a small diamond is inserted between its branches. These latter are afterward soldered while hot, and so expanded as to constitute a disk in which the diamond is inclosed without the interposition of any soldering material.

In the manufacture of these disks special arrangements are taken to have the position of the diamond, exposed by a proper finishing, vary from one to the other. In the disk of the saw as many cavities are formed as the saw is to have teeth, and each of these is formed according to two diameters upon the half thickness, for the reception of the disk. The mounting is then finished by a soldering of tin.

Between each of the cavities hollows are made in the saw, so that the diamonds may cut well into the stone. We shall now describe the arrangements devised by the manufacturers for the use of the saw thus constructed.

Figs. 1, 2, and 3 represent the machine adapted for the sawing of blocks of small dimensions, the carriage of which is relatively easy. As may be seen, the diamond-set disk, A, is fixed projectingly at the extremity of a shaft, B, resting upon the two pillow blocks of a solid cast iron cross piece, N, which is carried by the frame, P, upon which it is capable of sliding vertically.

The saw disk, plentifully watered by ajutages, is held between guides that can be regulated at will, and are

situated at extremities of a same diameter, in order to prevent the wobbling of the saw that might result from its contact with the stone before beginning to cut. Once begun, the groove itself serves as a guide.

The pedestal, G, of the frame, P, has a wide base, so that the machine may have a solid foundation. This expanded portion is cast in a piece with supports that receive the rails of the carriage that carries the stone to be sawed. Beneath, and in the axis of the carriage, H, there is a helicoidal rack, R, actuated by the endless screw, J, of a longitudinal shaft which is capable of revolving at various velocities and of thus giving various degrees of advancement to the work. The parts employed to obtain this result are clearly shown in our figures. There will be seen also to the right a mechanism driven by a special belt and giving a rapid backward and forward motion of the carriage in order to shorten the time of the maneuvers.

As the cross piece of the saw shaft is capable of sliding vertically upon the frame, it is possible to vary at will the depth of the saw's penetration, thus permitting of cutting stones into slabs or of making grooves economically.

This machine requires the displacement of the stone upon its carriage. When it is desired to make a second cut alongside of the first, nothing is easier than to avoid this maneuver. To this effect the manufacturers have established another model in which the frame slides upon the pedestal of the machine. The first may thus be displaced according to needs, in order to make in a stone, keyed once for all, as many parallel incisions as may be necessary.—*Revue Industrielle.*

PRACTICAL NOTES ON OILS AND FATS.

THERE exists a very large number of oils and fats of both natural and artificial origin; every animal and plant yields an oil or fat (in some cases more than one) which differs in some feature or another from one another; then there are the oils obtained from shale, petroleum and coal tar. The uses of oils and fats are nearly as numerous as the bodies themselves. These uses may be divided into two groups—domestic and industrial. Some oils are used solely for domestic purposes, while others are used only for industrial purposes. It is with the latter class of oils and fats that it is proposed to deal in these notes.

These bodies naturally divide themselves into two groups—the fat oils and hydrocarbon oils; the former are of natural origin, the latter of artificial production. The fat oils have been longest known, and have the most varied uses, lubricating machinery, soap making, dyeing, manufacture of textile fabrics, besides numerous smaller uses of a domestic and industrial nature. The hydrocarbon oils are of comparatively recent introduction into use, and they are not used for as many varied purposes as the fat oils; but they have become, since their first introduction in 1858, of considerable importance, especially for lubricating machinery. The two groups of oils differ very much in their chemical composition. The oils of both groups are not simple compounds, but are more or less complex mixtures of several compounds of very similar properties; this, combined with the fact that these bodies have no very distinctive difference one from the other, makes the analysis of oils a matter of very great difficulty.

The fatty oils are compounds of glycerine, a basic body, with two or more acid bodies, fatty acids, as they are called, so that considered from a chemical point of view the oils are salts, *i. e.*, compounds of an acid and a base. There is only one base in all this class of oils, glycerine, but there are many acids called the fatty acids. As a rule there are two at least in every oil, often there are more. Cocanut oil contains about nine, tallow only contains two. Of these acids there are three which are found to a greater or less extent in all oils and fats: these are oleic acid, the characteristic acid of olein, the fluid constituent of oils; palmitic acid, the characteristic acid of palmitin, the solid constituent of vegetable oils and fats; and stearic acid, the acid of stearin, the solid constituent of animal fats, and which is often present in vegetable oils. Besides these there is lauric acid found in cocanut oil, linoleic acid found in linseed oil and other drying oils, butyric acid found in butter, ricinoleic acid in castor oil, brassic acid in rape and colza oils, valerianic acid in whale oils, and many others.

Without going very deeply into the division of these bodies into groups, they roughly divide themselves into three groups—non-drying, drying, and intermediate oils. Although there is no strongly marked line of demarkation between them, the non-drying oils shade off into the intermediate oils, and these into the drying oils.

The non-drying oils include olive oil, rape oil, colza oil, lard oil, ground nut oil, sperm oil, castor oil, and a few others of less importance. They are very useful as lubricating oils, and for this purpose they are still largely used, although they have of late years been displaced to a large extent by hydrocarbon oils. Sperm oil is unrivaled as a spindle oil, castor oil is excellent for lubricating heavy shafts, engine bearings, and heavy machinery generally; olive oil is not as much used as formerly for lubricating, the better qualities are used as cooking oils, which is perhaps the original use of this oil. As a soap oil it is much used; the best qualities give a good white soap, the commoner ones a green colored soap much used by calico printers, dyers and wool washers, who often judge of the quality of an olive oil soap by its color—a very poor criterion, as the color of a soap can easily be imitated. The true criterion is the amount of actual fatty matter it contains, and whether it has been well made. These are points which are applicable to all soaps. Olive oil is much used as a wool batching oil, for which purpose it has probably no equal. Of all oils it is the one which is most frequently adulterated, especially with cotton seed oil; the best test for olive oil is unquestionably the elaidin test with nitrate of mercury, and the indications of this test may be confidently relied on. Rape oil is used for lubricating machinery, especially in combination with mineral oils. Its chief use is for burning in carriage lamps, for which purpose it has no superior—it burns with a clear, smokeless flame. Colza oil is mostly used for the same purpose, especially in table lamps. Rape and colza oils which are to be used for this purpose should be free from acid, the presence of which much reduces the luminosity of the flame. The presence of fatty acids in oils is readily ascertained by taking a small quantity of the oil and adding to it a little of a solution of phenol phthalein methylated spirits to which some caustic soda has been added to give it a red color. If there be any acid in the oil, the red color of the test solution will be discharged. By always taking the same quantity of oil a comparative idea of the quantity of acid in the samples tested may be obtained. The best tests for rape and colza oils are the specific gravity, which should not exceed 0·915 at 60° F., Maumene's test, and Koettstorfer's saponification test. These oils take about 17 per cent. of caustic potash to saponify them. Most oils which would be used to adulterate them take about 19 per cent.

Ground nut oil, which comes or is obtained from the monkey nut, the fruit of the *Arachis hypogea*, is not as much used as it might be. It is not as good a lubricating oil as olive or rape, owing to its having a slight gumming tendency. It would make a very good wool oil, but some absurd regulations of insurance companies prevent its use for this purpose. It is quite time that these companies overhauled their regulations in regard to the use of oils in mills, and placed the matter on a more scientific basis than it is at present. Nut oil makes a very good soap, hard, white, and a good lather-er. It is also used as a food oil, for which purpose it is quite as good as olive oil. It is never or rarely adulterated, but is oftener used to adulterate other oils.

Lard and tallow oils are pressed from lard or tallow as the case may be. Animal oil is also pressed from tallow, but is usually of rather better quality than what is sold as tallow oil. Ox oil is another name for this product. They vary much in quality, perhaps more so than any other kind of oils; some samples are quite fluid at ordinary temperatures, others are solid; some are free from all traces of fatty acid, while others contain as much as 12 to 14 per cent. The best qualities make good lubricating oils, and are much used for that purpose, especially in combination with mineral oils. They are good soap oils, although their cost stands in the way of extensive use; as wool oils they are useful. From tallow oils to tallow itself is not a far cry. As with a good many other things, there is tallow *and tallow*. Tallow should be the hard fat of the ox, cow, or sheep, melted down to free it from the animal tissue with which it is associated in the body of the animal. This fat is found surrounding the abdomen and the muscles of the animal. The bones and other parts also contain fat, and this is often extracted. This is often sold as tallow, but is not tallow; of this fat something more will be said presently. Tallow is the soap material par excellence. There is no better soap than a piece of good, well-made tallow soap, and most of the tallow which is rendered is used for soap making. Formerly it was very largely used for lubricating steam engine cylinders, but there is comparatively little now used for that purpose, and it cannot be recommended as a cylinder oil. It has a tendency under the combined influence of heat and steam to which it is exposed in the cylinder to decompose into fatty acid and glycerine, neither of which has any lubricating property. On the other hand, the fatty acid accumulates in the cylinder, and exerts a corrosive action on metal, pitting the surface, and eating away bolts, etc. A cylinder lubricated with tallow always works dirty. Another use of tallow is in candle making, in which it is used either as it is obtained from the rough fat or as pressed tallow. For candle making it is necessary to use the hardest tallow that can be obtained, as this contains more stearin than a soft tallow, and it is the stearin which makes the best candles.

Bone tallow, tripe tallow, and other varieties of poor animal fats, are much used for making common soaps for industrial purposes; such fats should always be tested for the actual amount of saponifiable matter they contain, as the writer has found them to contain water in notable quantity, also animal tissue and other unsaponifiable matter. In one case a sample was found to contain a quantity of soap, which had been formed by adding some soda to neutralize the free acid the fat originally contained. The use of the Soxhlet fat extracting apparatus will be found to give some valuable information on this point. Besides their use for soap making, these crude fats are largely used for the preparation of common lubricating greases. Their use for this purpose calls for no comment.

Sperm oil is generally considered by most oil dealers the perfect lubricant, and it is often used as a standard of comparison. There is no doubt that it has good lubricating properties, and as a spindle oil it can hardly be surpassed, but it is much too light for other kinds of machinery. Its cost is much against its use in these days. There are two kinds of sperm oil; one known as Arctic sperm oil, which is obtained from the bottle-nose whale, and is hence often distinguished as bottle-nose oil; the other is the true sperm oil from the true sperm whale, and known as Southern sperm oil. There is not much to choose between these two oils except in the matter of price, the Arctic being about half the price of Southern sperm oil. In all other respects they are nearly of equal value. Arctic sperm is usually not of so good a color or so sweet an odor as Southern sperm; as for its lubricating value, the latter is a little better than the former. The best tests for sperm oils are the specific gravity, which is 0·880, the flash point, which is 500° F., and the saponification value, which is about 12 per cent. of caustic potash. The usual adulterants of sperm oil are mineral, whale, and lard oils. The other fish oils call for no special mention.

Cotton seed oil is now of great importance. Its chief uses are for cooking and soap making. As a soap oil it is not a first rate material. It gives rather a pasty sort of soap, very soluble in water, as soaps go, which is a good feature from the soapmaker's point of view, but a bad one from that of a user. Another property of cotton oil soaps is that they develop a rancid smell on keeping. In spite of these and other drawbacks it is largely used for making soap, especially in the cheaper qualities. As a cooking oil there is scarcely a better oil for the purpose. As a lubricating oil it is a failure, on account of its drying propensities, which are very great, and although when the process of extracting the coloring matter from the crude oil had been found out it was used as a lubricating oil, yet its use for this purpose had to be abandoned on account of its gumming the machinery. Of late years some very thick oils have been placed on the market, under various names, lardine, thickened rape oil. They have come of late to be known generally as blown oils. These are made from rape and cotton oils by heating to about 150° F., and blowing air through them. They gradually become more viscid and become heavier. They can be made having a specific gravity of 0·980. These thickened oils are largely used to give body to mineral oils, with which they mix freely. Whether they improve the oils with which they are mixed is rather doubtful, but there are no reliable data on this point readily available. The writer is of opinion that they are very unsuitable oils to be used for lubricating. They gum very much, generally contain a comparatively large quantity of free acid, which is a bad fault, although there has been some improvement in them in this respect of late. It is a pity that nothing is definitely known as to the real lubricating value of these thickened oils. Oil dealers who have such information in their possession would confer a great benefit on oil users by publishing it.

Linseed oil is used chiefly for painting, for which purpose it has no superior. There is a great difference between the various sorts of linseed oils. There is scarcely any doubt but that Baltic oil is the best, and it commands the highest price; no other should be used for making varnishes. East India oil is the worst quality of linseed oil in the market, and should only be used for common painting work. There is no very good means of ascertaining whether a given sample of oil is Baltic or East India or other variety of linseed oil. What can be done is to obtain some idea as to the quality of the sample. The best test is the specific gravity. This should be about 0·935. A light gravity may be taken as an indication of poor quality. Valenta's acetic acid test is a good one for linseed oil. The turbidity temperature ranges about 35° to 38° C., a good oil being always lower than a poor oil. Another good test is Maumene's sulphuric acid test. The increase of the temperature with linseed oil is very great, much greater than with any other oil, averaging as it does about 110° to 120° C., and the better the quality of the oil, the higher the increase. These three tests will be sufficient to obtain some idea of the quality of a sample of linseed oil. Boiled oil is or should be linseed oil heated with driers, such as red lead, litharge, manganese, to a temperature of 500° F. for some hours. By this treatment it becomes heavier. Its gravity rising to 0·945, its drying properties are considerably increased and when used in a paint it dries with a gloss. There are many substitutes for boiled oil. These necessarily vary in composition; turpentine, linseed oil, resin oil, petroleum spirit, and boiled oil form the staple ingredients with which they are made. As a rule they are only very poor substitutes for the genuine article. If they contain resin oils they are bad drying oils, always remaining more or less sticky; at the best they are only fit for very common work. To test the quality of boiled oils there is nothing like a practical test, coating a piece of glass or wood with the sample of oil, and seeing how it dries, whether quickly or slowly, with or without a gloss, whether it gives a hard and brittle or elastic coat, and, what is important, whether the coat after drying becomes soft on standing for a week or so. This latter is a bad quality, but it is very likely to happen with some patent boiled oils.

Palm oil does not require an extended notice. It is characterized by its orange color and peculiar odor. As a rule palm oil is not adulterated. It varies very much in quality; in fact, there is no oil which varies as much as palm oil. The acidity will range from as low as 10 per cent. to as much as 75 per cent. The color also varies; the best qualities are highly colored and difficult to bleach, the worst are paler and are easily bleached. The bleaching of palm oil is best done by means of bichromate of potash. Manganese is also a good bleaching agent.

Palm oil is mostly used as a soap oil, as it gives a very good soap, hard, with a pleasant odor, and a good detergent soap. It is also very largely used in candle making, in which case it is generally saponified, and the palmitic acid it contains is separated out and used as palmitin, and very good candles it makes. It is evident that for this purpose those palm oils which contain the most palmitic acid are the best. To ascertain this point, the sample should be saponified, the fatty acids separated, and their melting point determined; the higher this is, the better the palm oil for candle making. In a figurative sense there is too much "palm oil" in the oil trade, and which requires abolishing.

Cocanut and palm nut oils are two oils which are of interest, both from a scientific and an industrial point of view. These oils are chiefly used for making soaps, for which purpose they are excellent; they give good white soaps which have the very great recommendation of being very soluble in saline liquors, and hence are the soaps for sea water and hard waters in general; they take more alkali to saponify them than any other kind of oil, about 25 per cent. of potash. Cocanut oil soaps are very much used in the finishing of calicoes under the name of softenings. In their chemical composition these oils differ very much from other oils. They are more complex, contain many fatty acids, some seven or eight, some of which, too, have the property of being soluble in water, a property not possessed by the acids of any other oil or fat except butter, and to which the solubility of their soaps is due. Cocanut oil is the best of the two oils, although there is not much to choose between them. Palm nut oil is generally of a darker color than cocanut oil. They are really fats, not oils, being solid at the ordinary temperature, but they are easily melted, and then they form colorless oily liquids.

Castor oil is the only other oil which calls for special mention. It is characterized by being a very heavy, viscid oil, as oils go; its specific gravity is 0·964. It differs from the other fat oils in several particulars, it is completely soluble in alcohol, while other oils are not, it is insoluble in petroleum spirit or petroleum oils (this is a very bad feature of castor oil, as it prevents its use in lubricating machinery); if it could only be mixed with hydrocarbon oils for making heavy machine oils, it would be largely used. Many attempts have been made to blend these oils, but hitherto without success. Castor oil is a good lubricant for heavy machinery where the oil is subjected to great pressure. It is also used to make the cheapest kind of transparent soaps, castor oil soap being more transparent than any other soap. It is also more soluble, and it is possible to obtain a solution of it; such a solution was formerly made in large quantities and used in cloth finishing, under the name of soluble oil; this has now been replaced by another preparation of castor oil made by treating it first with sulphuric acid, then with caustic soda. This product is very largely used in calico printing, bleaching and finishing of cotton cloths

under a variety of names, soluble oil, oleine, Turkey red oil, etc., as these products can be mixed with a quantity of this substance without showing it. It follows that there is a great variation in the quality of them. They should be bought according to the quantity of fatty matter actually present in them.

The hydrocarbon oils next demand attention; these are obtained from three sources: Scotch shale, American petroleum and Russian petroleum; from each of these, three classes of products are obtained: naphthas, very light products, having a gravity of about 0·760, used in making varnishes and paints, burning oils having a gravity of about 0·810 to 0·820, and lubricating oils. As to the naphthas these should be as light as possible, and should all be distilled over at about 150° C. The burning oils should not be too heavy, a gravity from 0·810 to 0·820, heavier oils do not rise in the wick readily enough; with lighter oils an element of danger sometimes arises on account of their too ready volatility and inflammability. These oils should not begin to distill below 150° C., and should all be distilled at 300° C., the standard flash point is 73° F., but the best qualities of these oils flash at about 110° to 115° F. The best qualities are refined by distillation; such will burn clearly without much charring of the wick or the latter becoming incrusted. These oils are often refined by a washing process with sulphuric acid and caustic soda; the great fault of such oils is that they leave a crust on the wick which interferes with the quality of the light they give; otherwise they are as a rule good oils.

The lubricating oils from shale and petroleum are now of great importance. When they were first introduced they were very poor, dark, odorous oils, depositing in cold weather solid matter in no small quantity, and without much lubricating power. However, there has been a great improvement in these points, the color is now pale and bright, and is nearly all that can be desired; they have very little odor, and this is agreeable rather than otherwise. The solid paraffin is now almost completely extracted to the benefit of the oil refiner, and with an increase in the lubricating powers of the oils. The result has been that these oils have very nearly displaced the fat oils as lubricants.

The Scotch oils are light oils ranging in gravity from 0·865 to 0·890. The 865 oil is almost too light for lubricating; the 885 and 890 oils are very good oils for lubricating light machinery, such as spindles or spinning frames. American oils are of two kinds, pale oils produced by distillation, and dark oils obtained by a process of filtering and steam distilling. The former are used for general lubrication, and range in gravity from 0·890 to 0·920; the latter are thick oils, and are almost entirely used for lubricating steam engine cylinders, and are known as cylinder oils. The gravity of these is about 0·896. Russian oils have only been recently introduced into the English market and their capabilities have not yet been found out. They are very different from either Scotch or American oils, are more viscid, but they lose their viscosity more readily under the influence of heat than do the other oils; hence while being very good lubricants at ordinary temperature, they are but poor ones at high temperatures. Russian oil contains no solid paraffin, so that these oils remain fluid at much lower temperatures than any other oils, and are therefore specially valuable as lubricants in cold climates and cold places. Their gravity ranges from about 0·890 to 0·915. They are much darker in color than Scotch or American oils. This probably arises from the fact that they cannot be subjected to as strong a purifying process as the other oils can. There has been some improvement in them in this respect of late, and they are coming over much paler than formerly.

The hydrocarbon oils are very complex in their composition. They are more or less complex mixtures of several compounds of carbon and hydrogen, hence their name hydrocarbon oils; their older name, "mineral oils," comes from the fact of their having been first obtained from the mineral shale; the hydrocarbon bodies of which they are composed belong to three distinct groups: paraffins, characterized by being acted upon by strong acids and alkalies; olefines, which are more readily acted upon by strong acids, but not by alkalies; naphthenes, which resemble the olefines in their properties, but are heavier and more viscid. The first group are most abundant in American oils, the second in Scotch oils, the third in Russian oils. These oils then are perfectly neutral in their properties, have no tendency to oxidize by exposure to air, do not act on metals, cannot be saponified by alkalies, and are practically unchangeable in any conditions to which they may be exposed while being used as lubricants. It is worth while laying stress on the fact that these oils cannot be saponified by treatment with alkalies, because many persons have attempted this feat, and, of course, without success.

The principal points of these oils, by which their relative value is judged, are, 1st, specific gravity; 2d, viscosity or fluidity; 3d, flashing and fire tests. There are a few other minor points, such as solidifying temperature, evaporative tendency, etc., but these are only rarely taken into account.

The specific gravity of an oil is usually taken by means of a hydrometer. This is a very simple method and gives accurate results, provided the hydrometer is correct, but many of the cheap instruments are far from being correct, and, therefore, their indications cannot be relied on. The best method is by means of a specific gravity bottle; this gives perfectly reliable results. The Westphal gravity balance is a simple and accurate method of determining the gravity; in all cases the temperature should be taken into account, and the results corrected accordingly, the allowance being 0·00064 for each degree C. above or below 15·5, or 0·00035 for each degree F. above or below 60; if the temperature is above these points the correction is added, if below it is subtracted. Gravity, however, is only a minor point, and is at the best only a rough indication of the possible use of an oil; thus an oil having a gravity of 0·910 is too heavy for a spindle oil, and rather too light for an engine oil.

The viscosity or fluidity of an oil is really its most important property. An oil may have a high specific gravity, but if it has no viscosity, "body," as it is often called, it is useless as a lubricant, while a light oil with a good "body" will work well. The viscosity of an oil is generally tested by noting the time it takes to run out of a small aperture, a pipette or a glass tube drawn out to a fine point at one end being generally used. Unfortunately there is no recognized "standard" for viscosity, although it is far the most important property of a lubricating oil.

The instruments in use by oil dealers do not give concordant results; this is due to the fact that nearly all viscometers are made of glass, and it is practically impossible to make two alike. Mr. Boverton Redwood has invented a standard instrument which gives good results, but it is open to some objections, and it is doubtful whether it will be largely adopted.

The writer has seen and worked with two other forms of standard viscometers which have given very good results. One of these, it is expected, will be offered for sale shortly.

The viscosity of an oil influences the use of it; a thin light oil can only be used for lubricating light, quickly running machinery; a thick oil, only heavy, slow moving machinery, hence a spindle oil which gives good results when used to lubricate spindles would not lubricate a shaft, and similarly a good shafting oil generally makes a bad engine oil. That oil is best which loses least of its viscosity under the influence of heat. The viscosity of an oil should therefore be tested at various temperatures, say 70°, 120°, 180°, and 212° F. It is by no means uncommon to have two samples of oil which have about the same viscosity at 70° but which are very different at 120°. In the case of cylinder oils the viscosity at 70° is no criterion of its value; some of these oils are solid at that temperature, others are just fluid, yet sometimes these latter oils have a better viscosity at 212° than the former. Cylinder oils should always be tested at 100° and at 212° F.

The flashing point of an oil is a very important feature as being a rough indication of its suitability for lubricating the special machinery it is intended for. Unfortunately the flashing point of an oil is not thoroughly comprehended by many oil dealers, who have about as much real knowledge of oils as an infant has; they talk learnedly about high flashing points and will not look at an oil unless it has a high flash point. In the same way many regard the viscosity as the feature of an oil, and their oils always have a "good body;" these gentlemen have no idea that the viscosity or body and flash should be regulated by the special kind of lubrication that the oil has to do. Another feature of the flash test is to see whether an oil is safe to use. Some mineral oils give off an inflammable vapor at a low temperature; such oils would be rather dangerous to use in a cotton mill where the temperature is rather high and may be above the flashing point of a very light oil. As a rough guide the following temperatures may be taken: Spindle oils, 350° F.; shafting oils, 380° F.; engine oils, 400° F.; cylinder oils, 500° F. In the latter cases high flash points are wanted, not because an oil of lower flash would be unsafe, but because an oil having a lower flash would not have the necessary lubricating power. The flashing point is generally determined by placing a small quantity in a porcelain basin and heating it gently over a Bunsen burner so that the rate of heating does not exceed about 10° F. per minute; when the temperature has risen to somewhere near what the flashing point is thought to be, a small flame is brought near the surface of the hot oil; when a blue flame is seen to flash over the surface, the temperature is taken by a thermometer which is immersed in the oil, and this is the "flashing point." A better method is to use a copper vessel as giving a more uniform heating of the oil. Some dealers immerse the vessel in a sand bath, but this is not necessary and gives very little, if any, better results than simple heating over the burner, while the time it takes to make the test is much lengthened. The fire test of an oil is the temperature at which it will keep alight. This is always higher than the flash point, but there does not seem to be any regular connection between the two points; in this country the flash is considered of the most importance. In America the fire test is the criterion of value in an oil. With the exercise of due care in making this test there should not be much difference between the results of different observers; absolute agreement cannot be expected, but the difference should not be more than a few degrees.

There is another point in connection with oils that is of some importance where they are used in textile mills, and that is whether they are liable to produce stains or not on fabrics. A good many so-called "stainless" oils are now being offered. There is a very large quantity of oil used in lubricating textile machinery. However careful the operatives may be, some of this oil is sure to find its way accidentally on the yarn or cloth. Now neither the spinner nor the manufacturer desires these splashes of oil to show, so they go in for stainless oils, but oils such as are nowadays used in the textile mills are liable to give rise to three kinds of stains: First, temporary oil stains, which are eliminated by the scouring process. Second, metallic stains. These are produced by the oil taking up small particles of metal from the machinery, and these are fixed on the cloth during any subsequent bleaching or scouring processes. Such are liable to happen with any oil, however good in quality it may be. Third, permanent oil stains. These are by far the most objectionable. After the cotton or wool has been spun into yarn or woven into cloth, it has to be bleached; any oil stains which are in the fabric may or may not be extracted. If a pure fat oil has been used, then they will be completely removed. If, on the other hand, a mineral oil has been used, then it is doubtful whether the oil will be completely extracted. The stains in such cases will be permanent, and unfortunately the bleaching agents used act on the oil and cause it to gradually turn yellow.

Cases occur where a piece of cloth which left the bleach house perfectly and uniformly white has often an undesirable tendency to develop yellow patches. There are no practical means of taking out these stains. These stains are only produced when hydrocarbon oils are used, but whether a particular sample of oil is really "stainless" or not cannot altogether be deduced from its chemical composition. Other factors come into operation, such as whether the oil contains any fatty matter, the length of time between the oiling and bleaching, the kind of mineral oil used; all these and others enter into the question.—*Chemical Trade Journal.*

An electric welding machine for making chain cables is among the latest applications of electric welding. It has been found possible to weld two links at the same time.

THE TREATMENT AND STORAGE OF BEER.*

Cask Selection.—Whether the casks are previously examined by the coopers or not, they should always be passed by the best available man in the cellar prior to racking. In large breweries there must, of course, be several passers-in, and it is never advisable to allow one man to pass very many casks at a time. The sense of smell becomes deadened, and, from sheer inability, he will be sure to pass many that he would have rejected at an earlier period of his work.

A very prevalent trouble during the warmer months is the tendency to acidity or sharpness. These sharp casks are fatal to the stability even of quick-running beers. Such casks should be soaked in a hot solution of salt and soda. After emptying and rinsing, they should be well treated with sulphurous acid, with the object of destroying the acid ferments in the pores of the timber. After rinsing with sulphurous acid, the casks should be left some few hours tightly corked and bunged; they can then be steamed out ready for use. Cask sharpness is often intensified by allowing the empties to lie about exposed to the heat of the sun, when the film of residual beer is very prone to acidification, owing to the influence of air and high temperature combined.

Racking.—This is done either direct from the primary fermenting vessel, or from the dropping square, or from the settling or racking back. If cleansing in a secondary vessel be deemed advisable, it can be best accomplished in the dropping square, which retains its natural covering of yeast. The transference of finished beer from vessel to vessel is most prejudicial, owing to the oxidation to which it is exposed. But upon the dropping system the beer is in more or less active fermentation when the change takes place, and it is at any rate supersaturated with gas, which reduces the absorption of air. Racking backs are in many plants essential as a means of collecting the contents of several primary fermenting vessels. They are most convenient for blending purposes. It is hardly necessary to remark that the beer should be led into these backs at the bottom, so that fobbing and consequent oxidation may be as much as possible prevented. From whatever class of vessel the casks are filled, it is important to avoid absorption of air. Racking with the ordinary hose or stocking is most objectionable, on account of the fobbing which occurs by reason of the delivery end floating on the surface of the rising beer. To obviate this, it is a good plan to attach a tinned metal thimble to the end of the hose, of sufficient weight to keep it in position close to the bottom of the cask, the length of the hose being adjusted with this object.

Cask Hops.—They have four principal influences, which are exerted upon the flavor and aroma of the beer, and upon its stability, condition and clarification. They affect condition in two ways. They undoubtedly carry with them into the beer certain ferment organisms, which must to some extent influence the secondary fermentation. It is probable that in this respect their influence is not always a desirable one, and that some of those unpleasant flavors that are noticeable in dry-hopped beers might be traced to these organisms. It would be a great improvement if the hops could be washed, or in some way sterilized before they are used. But the cask hops have another and very direct effect upon secondary fermentation, which is due to the increased agitation of the beer whenever the casks are moved. The influence of motion on fermentation is an accepted fact, and is probably chiefly due to the bringing of fresh volumes of wort or beer into direct contact with the yeast cells, and to the dispersing of the exhausted media, and retarding products of fermentation which surround them.

With regard to the influence of cask hops upon clarification, this is rather a mechanical than a chemical one. There are many who hold closely to the idea that clarification depends upon the hop tannic acid. The author maintains that the action of finings is independent of this body. The influence of the hops is of chief importance in promoting the spontaneous brightness of the beer. They afford a large amount of surface attraction whereby the semi-soluble and floating particles in the beer are removed from suspension. In the author's opinion they help to keep the coagulated gelatin in a compact mass, and so prevent it from breaking up into lumps, which so often constitutes a trouble with running beers that are not dry-hopped.

Secondary Fermentation and Condition.—The secondary or cask fermentation is of the highest importance in the production of our best qualities of ales. The aim of the brewer now is to accelerate the cask fermentation as much as possible, and to bring his ales into ripe condition with the least possible delay. Healthy cask fermentation is now known to depend upon the action of secondary yeasts, of which there are several types and mixtures, giving rise to different characteristics and flavors. During the slow and prolonged fermentation in cask, the palate of the beer is greatly modified by the products of the secondary yeasts, and the formation of various ethers which give that peculiar vinous character to stored beers. Secondary fermentation is also of the utmost importance in regard to the clarifying capacity of beers. It is often found that beers which are more or less dull after fining when fresh, readily become brilliant after a few weeks' storage in cask. Apart from flavor and brilliancy, cask fermentation is essential to that briskness or gasiness usually expressed by the term condition, and which is due principally to the action of secondary and bottom ferments upon the malto-dextrin in the beer. These ferments have the power, not possessed by the primary types, of breaking down the malto dextrin into maltose, which is then fermented. Consequently in natural cask fermentation malto-dextrin plays a principal part. This body not only imparts fullness and head, but also, by its gradual decomposition, promotes the steady evolution of gas, causing the beers to retain their life on tap.

The addition of sirup or priming has two principal effects—namely, the imparting of a lusciousness to running beers and the accelerating of those cask changes upon which the flavor and briskness of stored beers depend. It is often dangerous to employ priming in running ales during summer, especially if they are insufficiently clean, as the primary yeast cells are rendered too active, and unhealthy cask fret is promoted. In winter, quick-running beers are usually much im-

* A. Hartley. Trans. Institute of Brewing, 4, 33-51.

proved by priming, if the yeast is in healthy condition. If there is a preponderance of unsuitable ferments, it is unwise to stimulate their action, and when beers are a little out of health, priming has usually to be dropped. The two principal objects may be attained by two different classes of sirup. Lusciousness by a solution of invert sugar, which also acts as a stimulant to condition; and rapid condition or briskness, where sweetness is an objection, by glucose priming.

The action of the secondary yeasts in breaking down the malto-dextrin, in beer, may be supplemented by the employment of a cold water extract of malt. So powerful is the diastase thus obtained, that half a pound of grist has a distinct influence on 100 barrels of beer. This quantity should be steeped in two pints of water for some six hours and then strained. The diastase liquor is afterward added to the racking back, and well roused in. If there is no racking back and no opportunity of adding it to a large bulk of beer, it can be mixed with several gallons of beer, and the correct proportion added to each cask. With a sufficiency of malto-dextrin in his worts, the brewer thus has a further means of determining the condition of his beers. If intended for lengthy storage, he will wait for the gradual degradation of the body by the cask ferments. If he requires rapid condition, he will employ cold malt extract at racking. The practice of adding malt flour as a priming to stouts is a very old one, but its true significance has only been recently discovered. It acts similarly to the cold water extract of malt, but the latter is decidedly preferable, especially for ales, owing to the absence of husky particles.

Beers that are hopped should always be well rolled every day for about a week before they are topped up and shived down, so that the hops may be thoroughly soaked, and the maximum of absorption obtained. After shiving, they should again be rolled, daily if possible, for at least a week before they are stacked away.

Cleansing in Trade Casks.—By cleansing is meant the elimination of the residual primary yeast before the casks are shived or bunged. The beers are racked a day or two earlier than is customary on the ordinary system, and the temperature should not be cut down quite so low. They are racked into cask with a little life left in them, so that the primary yeast may work out as much as possible through the bung hole. The casks need slight topping up once or twice a day for a day or so, and it is remarkable what an improvement this slight amount of cleansing makes in the flavor and eventual brilliancy of beers so treated. This system also gives very good results with pale ales, with which cleanness is so highly important. If these ales are thus worked, it becomes necessary to postpone the introduction of the hops until the process of cleansing is finished. This may be several days. A little ale has to be siphoned out to make room for them, and it is more convenient to wet them first. After the addition of the hops, the casks should be bunged and rolled occasionally for a few days longer before they are topped up and shived. In breweries where it is difficult to attain satisfactory cleanness at racking, this system is recommended, as it is undoubtedly prejudicial for the beers to be closed down with any large percentage of primary yeast remaining in suspension.

Preparation for Bottling.—Preliminary cleanness is very important in the case of beers intended for bottling. Unless sufficient brightness at racking has been secured, the process just referred to is very beneficial. Indeed, it may be improved upon by bunging down and rolling the casks well every day prior to being topped up. The agitation of rolling enhances the assimilative capacity of the yeast and the elimination of those bodies that cause undue yeast growth in bottle. In the production of beers for bottling it is most important that there should be a minimum of matter that either comes out of solution during the bottle fermentation or stimulates unnecessary yeast reproduction. This essential cleanness can only be satisfactorily accomplished by the aid of sound and vigorous secondary fermentation in cask. After shiving, beers for this purpose should be rolled with more than ordinary assiduity, with a view of obtaining, if possible, spontaneous clarification, the very best proof of natural cleanness. But it often happens that beers which are comparatively clean and have passed through their secondary fermentation will not drop sufficiently brilliant for bottling in the time required. Recourse must then be had to fining. But it is a mistake to suppose that beers are fit for bottling simply because they go bright with finings, unless they have undergone cask fermentation. New beers are certain to throw a heavy deposit, and are very likely to be cloudy in bottle. There is a somewhat popular idea that beers should be flattened before they are bottled. The excess of gas must be let off through porous pegs, but the greatest care should be taken to exclude any air, which is fatal to brilliancy. If fining has to be resorted to, the smallest efficient quantity should be added, and the casks should be allowed to settle for at least a week.

Temperature.—For pale ales and stock beers a moderate one of about 55° F., when it can be maintained, is the most satisfactory. Temperature has a decided influence upon the flavors developed during cask fermentation, in the same way as during primary fermentation. Cellars that receive running beers may be somewhat warmer than those used for stock and pale ales; but it is not advisable to allow the temperature to much exceed that which may be expected in the cellars of the consumer, for in winter there is danger of chilling, after fining, which causes lack of brilliancy. This effect of temperature reduction is the result of bodies that are only just soluble at higher temperatures coming out of solution. The cleaner the beers, the less likely this trouble. The heat of the beers at racking ought, as a rule, to be a few degrees lower than the likely temperature of the store. Stock beers may well be several degrees below, as the rise in heat will cause expansion, and so prevent ingress of air through crevices in the casks.

Fining and Sampling.—The use of old beer for this purpose is unsound both in theory and practice. The main point to be observed in the manufacture of white finings is sufficiently lengthy steeping. Good finings cannot be made in a hurry. The glass should be steeped for at least a month before it is passed through the finest sieve. It is a good plan to put the steep through a coarse sieve as soon as the glass is soft enough, as further softening is much hastened. If a little water is added daily, and the mixture is kept well roused up, it is usually ready for coarse sieving in about a fortnight. In regard to quantities and proportions, much of course depends on the quality of the glass, which may be very variable. With good Penang leaf, a gallon and a half of sulphurous acid and one pound of tartaric acid may be used for every seven pounds of glass. These quantities should make two barrels of white finings, with the daily additions of water made up to a definite strength. This can be tested by the viscosity tester, the time occupied by a definite volume of finings in passing through a small hole giving the comparison required. A definite working standard can thus be easily fixed.

Color.—The question of color is in many breweries a troublesome one. Standard sample bottles are very useful, and may be made with orange aniline dye and caramel mixed. These bottles must be made up with half methylated spirits to prevent settlement and loss of color.

Yeast Pressing.—Where there is a good proportion of stout and porter, there is no trouble in working off pressings at a good profit. It is most important that yeast should not be allowed to get stale, and in some smaller breweries this is the tendency. The most satisfactory plan is, of course, to press every day, and certainly it should not be done less often than twice a week. In summer, if pressings have to be kept some few days before blending, salicylic acid is the best thing to use as a preservative. Sulphites give an unpleasant flavor and smell.

Waste.—Waste is a most unsatisfactory thing to deal with. When, however, there is a demand for aged beers, there is not any trouble in getting rid of it at a good profit; but in many breweries it is impossible to dispose of the entire waste of a public trade by blending, without prejudicing the character of the beer. It often pays best to allow so much per barrel, and to refuse to receive the waste. When they can be worked up, it is usual to vat them, and if this is done, the more hops that are added to the vat, the better.

Returns.—The working up of returns also requires great attention. There are four different kinds: acid, flat, turbid, and casky. The working off of flat returns is the easiest of all. They can be added direct to running beers. Casky returns are practically impossible to deal with, and are best turned down the drain. Some forms of turbidity are very difficult to overcome. They are improved very often by intermixture with acid ones, but when much is returned on this account, it is not wise to blend sours with them, as the acidity may increase, and so enhance the difficulty of blending with mild-flavored ales. Hopping, as suggested in the case of waste, is the best treatment, combined with rolling when the quantity is not sufficient for vatting. Time usually brings brightness, and until this has been tried they should not be worked off. Acid returns need very careful working off. They may, of course, be neutralized, but this treatment requires considerable skill, and is not, in my opinion, very satisfactory. They may be heavily treated with salicylic acid, to prevent them from becoming worse. The returns of each day should be regularly tasted and sorted, and the casks should be marked for special treatment according to the complaint; if sour, for soaking, if casky, for the cooper. All little lots should be turned into odd-and-end casks, no ullages should be left on hand, and everything should be done to release as many of the trade casks as possible. If the quantity is large enough to employ a vat, the returns should be pumped over at the earliest opportunity. Everything that is fit to use up at once should be immediately blended off. Acid and turbid returns must remain in cask or vat until practically bright. By daily supervision of the returns, it is possible to greatly facilitate working up, and to avoid a great deal of unnecessary trouble and loss.

Preservatives.—With good malts, sound mashing systems, and thorough cleanliness, preservatives are seldom required, but with doubtful materials, the judicious employment of antiseptics is advantageous. If, however, they are added in excess, much more harm than good accrues, on account of their retarding influence on cask condition, which is so important in regard to stability. The basis of most preservatives is some sulphite, or mixture of sulphites and salicylic acid. Salicylic acid is very useful in many cases, especially for running beers brewed from low-class materials. But for ales that are required to come into early condition, it is not satisfactory. There is an impression that the antiseptic power of the sulphites depends upon their affinity for oxygen, and that they owe their action to the absorption of oxygen existing in the beer. But the change from the sulphite to the sulphate is practically a very slow process, and there is a large excess of oxygen in the beer that cannot be attracted by the small amount of preservative employed; their antiseptic action must, therefore, be due to some more direct influence upon the organism. The sulphates and chlorides present in brewing liquors are, of course, very important natural preservatives, and the additions that are often made to the liquor are very useful, both directly and indirectly, in promoting the stability of the finished beers. But of all preservatives, cleanliness is the best, and without it stability and character are unattainable.

Cleanliness.—In regard to the cleanliness of racking rooms and cellars, much depends on their construction. Cement, concrete, or granolithic flooring and glazed tile walls are, of course, the nearest to perfection. The surfaces of these departments ought all to be constructed so as to admit of thorough washing with a hose. Plain brick walls and old timber should be repeatedly washed with a mixture of freshly burned lime and chloride of lime, the latter at the rate of about one-sixth. For the flushing out of drains, chloride of lime is very useful. It is a good plan to mix some with cold water in an old cask at the rate of about four pounds per barrel. Add one pint of sulphuric acid, previously diluted in a wooden bucket with cold water. Allow the cask to remain for some few hours tightly bunged, and then empty down the drain. All wooden vessels, such as troughs and shoots, should be frequently scalded out, and occasionally painted over with sulphite of lime. Beer mains should have steam connections, and they should be steamed out every time they are used. India rubber hoses are sometimes difficult to keep clean. They must be flushed with cold liquor after use, and then hung up to dry. It is a bad plan to coil them up when damp. Hot liquor cannot be used for hoses without doing harm, and this is a great disadvantage. They may occasionally be charged with a weak solution of permanganate of potash without injury. All racking stockings should be scalded out every night, and hung up to dry, and a strict rule should be made of having all filling and topping-up cans and buckets well washed every evening, and set in a rack to drain. For the cleansing of wooden vessels, such as vats and racking backs, powdered pumice stone, laid on wet upon the brush, as suggested by Aldous, is very useful. Slate vessels can also be cleaned with it. For vessels of either material an occasional coating of sulphite of lime is beneficial.

PHOTOGRAPHY IN ANILINE COLORS.*

By A. G. GREEN, C. F. CROSS, and E. J. BEVAN.

IT does not require any very refined faculties of observation for the appreciation of the stupendous work continually brought upon the face of the earth by the sun's light and heat. In very early ages this appreciation has been signalized by the deification and worship of this great center of force; and if in these latter days of scientific investigation and exact knowledge we do not allow our feelings to carry us away in contemplating the great luminary itself, or the brilliant and mighty workings of its ceaseless energy, it is only because the struggle for the life which it inspires and sustains is too severe for more than occasional contemplation of the poetic side of the natural order. In the modern art of photography we have much that appeals to our most refined perceptions, both æsthetic and scientific, and the new photographic process which we have undertaken to bring to the notice of the Society affords an occasion, apart from its more direct application to æsthetic and utilitarian ends, not merely of extending our grasp of the *results* of modern science, but what is more important, of the phenomena upon which they are based. Our ordinary inquiries as to these results are too often limited to extrinsic considerations; we find them useful or beautiful, or both, and that is sufficient. The scientific spirit, on the other hand, leads us beyond the region of sensuous impressions into that of the ultimate components of matter and of force—an unseen world, but far more real to the scientific imagination than the visible arena of gross or aggregate results. If we are to understand how it is that light can so affect matter as to be able to impress itself by bringing about a permanent change in its composition—which is the essential idea of photography—we must know what are the ultimate reacting elements, dynamic and material. The factors of the problem are the *light*, or agent; the sensitive substance or matter acted upon; and the third, the inevitable *tertium quid*, or *medium* through which entities so totally distinct as force and matter are brought into reactive relationship.

We will begin with a few elementary considerations as to the nature of light.

To ordinary visual observation, a beam of sunlight is homogeneous luminosity. Most of us, on the other hand, are doubtless aware that science gives a very different account of solar radiation from what might be reasoned from mere sense impressions, showing it to be a highly complex aggregate of force—elements differing widely, not only in their dimensions, but in the phenomena to which they give rise. We may prepare the way for a short description of the results of analyzing solar radiation, and observing its ultimate components in detail, by an illustration taken from more familiar sources.

When we speak of the English army, we may think of it as the collective expression of the physical force of the English people; but when we think of the army in action, we picture infantry, cavalry, and artillery; and, further, each of these arms as made up of the actual fighting units or individual soldiers. So with solar radiation. We find it active in three distinct directions, giving rise to the effects of heat and chemical action, in addition to those of light; and that these aggregate effects—observable in the aggregate by the senses—are caused immediately by the unit constituents or force elements, of which we come now to speak more particularly. If we cause a convenient section of sunlight to pass through a prism of glass or crystal, we bend the light out of its course, and, as an additional result, it is decomposed into a band of colored light—the solar spectrum. In other words, the several constituents of solar radiation—thus spread out or separated—are affected by the prism in the order of their dimensions; and, in corresponding order, they affect the organ of vision, giving rise to the succession of color effects with which we are familiar in the rainbow. That these colored lights are the actual constituents of white light is easily proved, by causing them to pass through a second prism, conveniently disposed, so that the bending or dispersion may be reversed. From this second prism a beam of pure white light emerges.

On further examining the spectrum, we find that not only do the light effects vary from point to point, but that effects of heat and chemical action, which are caused by the constituents of solar radiation, also vary considerably. The heat rays we may regard as localized at the red end of the spectrum, extending considerably beyond the visible limit. The chemical activity of the spectrum, on the other hand, we cannot regard as localized, excepting for particular effects. Thus, for the more familiar processes of photography, the chemical effects upon which they depend are chiefly produced by rays situated toward the violet end; whereas in the photographic process which forms the subject of this communication a much wider range of activity is discernible, extending from the violet through the green, well into the orange portion of the spectrum. We shall revert to this, the more important part of our subject, after saying a few words as to the actual nature of the solar radiation, which manifests itself to us in this three-sided activity.

The older view, that it was a kind of matter emitted by the sun and transmitted to us through space, is no longer held; this cruder view has given place to the undulatory theory of the nature of radiant energy, according to which it is an undulatory disturbance or a wave motion in what is called the universal ether. With regard to this ether, we need only observe that the propagation of a motion through space postulates a transmitting agency or medium, and the enormous

* A paper recently read before the Society of Arts, London. From the *Journal* of the Society.

velocity of its propagation—186,000 miles a second—postulates a medium of very high elasticity. And this ether must evidently pervade all substances; how otherwise could we have the property of transparency or light transmission?

With regard to wave motion, we can only put forward one or two elementary considerations to enable those who have not considered the subject to form some mental picture of the effect. If we twist a corkscrew, we notice a propagation of a wave in the direction of the axis; this wave evidently is one of *form* only, as there can be no translation of the substance of the screw. The effect of wind upon a piece of standing corn is to create a succession of waves, which, again, are waves of form caused by the oscillation of the individual stalks to and fro in regular succession. Lastly, the waves of the sea are not caused by a forward movement of the body of water; it is an appearance of movement of this kind, but, actually, the disturbance of the water, *i. e.*, of the water particles, is in the vertical plane, that is, up and down. We will illustrate waves of this kind by means of a mechanical diagram, and conclude our brief description with the lucid definition of wave motion by a well known author as a continued transmission of a relative state of particles, their motion separately considered being, on the other hand, a reciprocating motion. Such we will take to be the nature of the waves of radiant energy. The lengths of these waves vary from point to point of the solar spectrum from 0·0000193 inch in the red to 0·0000099 inch in the violet. Remembering that the velocity of propagation of the disturbance is 186,000 miles per second, we may reckon the number of wave impacts per second upon an illuminated surface, arriving at numbers which surpass our mental grasp. We have now to inquire how the bombardment of these infinitely tiny waves can effect chemical decomposition, can undo the combination of matter with matter, producing in certain substances those changes which give, either directly (when a color change is directly produced) or by development (where colored compounds can be built up upon the surface affected by the light), photographic pictures.

If we bring together such a metal as silver—a simple or elementary substance—and the elementary gas chlorine, combination instantly ensues, attended by considerable evolution of heat. The product is a white compound devoid of metallic luster, and altogether different in external properties from either of the elements which have combined to produce it. Now, how can we decompose this product, chloride of silver, and restore the silver and chlorine to the free state? By putting back into the compound the energy of force which was set free and lost in the act of combination. This we can do in two ways. By means of the electric current or by the action of light.

The former admits of easy demonstration. Thus, on taking a suitable solution of the chloride, and inserting two copper plates connected at the terminals of a galvanic battery, there is an instant deposition of silver on the one, and the chlorine goes to the other plate. Now, the well known darkening of silver chloride on exposure to light is actually not so simple a resolution as that which we have demonstrated, but, essentially, it is the same. The darkened product is richer in silver than the original, and chlorine may be easily demonstrated to be set free in the process.

And this is a typical case of the action of light. It is an addition of energy to a compound, and an undoing thereby of the act of combination by which it was produced. Witness the stupendous work accomplished by light in building up the vegetable world around us. The raw material which is employed by nature is the carbonic acid of the air—a compound of carbon and oxygen. This it decomposes in the plant cell, restoring the oxygen, and building up the carbonaceous residue into the structure of the plant. To understand how the infinitely tiny waves of light which have no weight can tear asunder masses of substance, such as silver and chlorine, requires an exercise of imagination. There is an enormous weight of evidence to prove that all matter is made up of infinitely small masses, all equal, and equally endowed with the properties which mark the substance. These are the atoms of the chemist. These are in active motion. Chemical combination is a coming together of atoms. The heat and light evolved in combination is the result of the atomic collisions; and in consequence of the collision there is a loss of motion. It is these atoms—which are freely accessible to the all-pervading ether—which respond to the impulses of the waves of radiant energy; and it is in this invisible region, remote from sense impressions, that the phenomena which we are about to consider take place.

We shall confine ourselves to processes based upon the aniline or coal tar colors, since we find them completely typical of photographic processes generally.

The simplest method of producing a picture in any of these colors is based upon the familiar observation that these colors—dyed upon fabrics—all fade more or less on exposure to sunlight. This destruction is a complicated action, and therefore we shall not attempt to examine it in detail. We shall content ourselves with exhibiting prints obtained by exposing to sunlight, paper coated with two dyestuffs, which we select as specially fugitive, viz., eosine and methylene blue, under glass positives, as in any of the ordinary and familiar printing methods.

In these prints the gradations of shade are exactly reproduced; those portions which received most light are the most bleached, whereas the shadows of the object have protected the portions of paper beneath them, and by the preservation of the color the depth of shadow of the original is reproduced. We need scarcely to point out that such a method of photography has no practical value; not only is a prolonged exposure necessary, but the prints, in addition to being somewhat unsatisfactory in themselves, have this disadvantage—that, under the ordinary conditions of exposure, the color will continue to fade over the whole surface, with the gradual obliteration of the picture.

What we want to make such a process practically available is a compound possessing (1) a high degree of sensitiveness and (2) the property of entering into combination with some other compounds giving a product which will resist the further action of the light.

In the diazotype process, which is the main subject of this paper, we have as the actual photographic agent not only a highly-sensitive compound—highly sensitive, that is, to the action of light—but one which can be readily converted into a variety of coloring matters.

The process consists of four stages: (1) Dyeing or coating the surface upon which it is required to photograph with a particular compound, which is then (2) converted into a photo-sensitive derivative, and (3) exposed to the light under the usual conditions for giving the picture; (4) converting the sensitive compound wherever it survives, through having been protected by the shadows of the object photographed, into coloring matters; thus the picture is developed from the weakly-colored sensitive compound into well-marked shades of red, orange, brown, purple, or blue; and these shades being formed in stable coloring matters, the picture is at the same time fixed.

For the better understanding of the process it is necessary that we should acquaint ourselves with the properties of these substances apart from any reference to photographic action.

The compound we start with is a yellow-colored body,* to which the "trivial" name of primuline has been given. This compound is obtained by the action of sulphur upon toluidine, a coal tar base closely allied to aniline. In this action not only is there combination with sulphur, but several molecules of the toluidine are built up into one complex molecule.

Thus to express the matter in our modern formulæ, we start with $C_6H_4.CH_3.NH_2$ toluidine, and obtain—

$$CH_3.C_6H_3 < {S \atop N} > C.C_6H_3 < {S \atop N} > C$$

$$C_6H_3 < {S \atop N} > C.C_6H_4NH_2$$

primuline base. A very formidable-looking compound. Now the important part of this formula to us is not the unwieldy body, but the head, the small group NH_2. We can consider primuline in its simplified form $X.NH_2$, and we see that this differs from ammonia, $H.NH_2$, in having one H replaced by a complex group. Corresponding to this general resemblance, there is a similarity in their distinguishing property; both are basic or alkaline substances, and combine with all acids to form salts. One only of these we have to consider, that by combination with which the stable primuline—highly resistant to all agencies which destroy the more fugitive coloring matters—is converted into a photo-sensitive derivative. This acid is nitrous acid HNO_2. Nitrous acid and ammonia combine to form ammonium nitrite. When this nitrite is heated, it is resolved spontaneously into nitrogen gas—the inert constituent of atmospheric air—and water.

Now primuline, in common with all coal tar bases, combines with nitrous acid to form a species of nitrite, which is termed a diazo compound. All that we need note about these diazo compounds is that they correspond to the intermediate stage in the transition of the ammonium nitrite to the condition of nitrogen (and water) thus:

$NH_3.HNO_2$	$H.N\,N\,OH$	N_2
Ammonium nitrite.	$(-H_2O)$	$(-2H_2O)$
	$X.N{=}N.OH$	
	Diazoprimuline.	

These diazo-derivatives are, as a class, sensitive to light, undergoing decomposition with evolution of nitrogen gas. But what concerns us for the moment is their avidity for constructive or synthetic reaction with two large groups of coal tar compounds—the amines and phenols. With these they combine very much as the original bases combine with nitrous acid to form these active diazo compounds, and the products are the azo-coloring matters. We cite the more important of these, obtained from primuline. In the case of the several phenols, their alkaline solutions are employed; while in the case of the bases, acid solutions are used:

Primuline and nitrous acid give *diazo-primuline*, and diazo-primuline with—

β Naphthol.	Phenol.	Resorcin.	Pyrogallol.	α Naphthylamine.	Amido. β Naphthol
Red.	*Yellow.*	*Orange.*	*Brown.*	Hydroc.	Sulphuric acid.
				Purple.	*Blue.*

These relations we demonstrate with diazo-primuline and the several reagents above mentioned.

We now come to the photographic application of these reactions. The essential condition of primuline photography is (1) that these reactions take place with primuline after its application to any surface or material, such as wool, silk, etc., as a dye, without in the least affecting its union with the material; and (2) that the diazo derivative produced, in combination with these materials, by treating the primuline-dyed surface with nitrous acid, is photo-sensitive in the highest degree, far more so, in fact, than the derivative itself, when free or uncombined.

Having thus prepared the way, we proceed to a complete experimental demonstration of the process. We first show the building up of the coloring matters upon the cotton and silk fabrics, showing that the reactions take place in silk without disturbing the union between the coloring matter and fabric; and that the azo coloring matters so built up withstand the action of boiling soap.

We have now to demonstrate the sensitiveness to light of a surface dyed with primuline, and sensitized by treatment with nitrous acid, and we shall show that the action of the light is to destroy the diazo derivative, that this destruction is due to the splitting off of its two characteristic nitrogen atoms in the gaseous form. We are enabled to show this to an audience owing to the curious fact that in a gelatine medium the nitrogen, though liberated from combination, is not evolved until the gelatine is softened by contact with water. We expose a primuline-gelatine plate to photographic action, and on plunging into a transparent bath of water, an image of which is thrown on the screen, we see the form of the print instantly developed in minute bubbles of gas. On then treating the plate with one of our developers, we see that when the gas has formed—the evidence, *i. e.*, of the destruction of the diazo-primuline—there no development of color takes place.

We now develop a number of prints which have been exposed in the daylight, and brought here in the condition in which they left the printing frame. In these developed pictures the high lights are represented by the neutral tint—varying from buff to cream—of the product of destruction of the diazo derivative, the absence of development in these portions being due to the chemical inertness of this product.

The development of colors corresponding to the shadows and half tones of the object is exactly proportionate to their depth, to the degree of protective action which they have exerted on the sensitive surface beneath—in other words, to the quantity of diazo-primuline which survives.

Reverting to the considerations which we advanced in the early portion of this paper, we should explain the action of the light as an addition of energy or atomic motion to the molecule of the diazo-primuline, whereby the split or cleavage of the molecule at the point occupied by the two nitrogen atoms is determined, just as by adding heat to ammonium nitrite its molecule is resolved into nitrogen and a residue, which in this case is not a complex compound, but water.

We have already alluded to the fact that the rays which attack the diazo-primuline are by no means confined to the blue and violet constituents of the spectrum, but extend well through the yellow to the orange red. In other words, a primuline print is more nearly a measure of the visual intensity of the sun's rays than the sensitive substances used in the ordinary methods of photography, in relation to which it is well known that the photographic intensity of sunlight is a very different thing from visual intensity, owing to the enormously greater activity of the blue and violet rays—*i. e.*, those of least visual intensity—in decomposing the compounds which they employ.

It will be convenient here to point out another contrast of this method with those more commonly employed. The prints obtained with it are positives, the light and shadow in the object being exactly produced in the colored picture. Natural objects, therefore, of convenient form, such as leaves, may be photographed directly; reproductions from camera pictures require glass positives, or positive paper prints made transparent in the usual way with vaseline.

In view, perhaps, of the chemistry of the method, it would perhaps be more correctly termed a negative method, since the action of the light is destructive, and where it acts, the construction or development of the color is rendered impossible. In the ordinary methods, on the other hand, the light is an agent, as it were, in the synthesis of color—where there is most action the deepest tones are developed—and the photographic action would in this case perhaps be more correctly termed positive. The point, however, is not a very important one.

There now remains to be noticed a second photographic process based upon the peculiar properties of the diazo derivatives of the coal tar bases; a method which, to use the ordinary term, is a negative one, *i. e.*, the light plays a constructive part in the development of a colored picture.

When the diazo compounds are treated with an alkaline bisulphite, they are converted into the diazo sulphonates. These compounds are sensitive to light, the action of which is to set free the diazo group from its combination, but they do not react with phenols and amines, as do the diazo compounds. The mixture of a diazo sulphonate with the latter is unattended by any color reaction, but, on exposure to light, the diazo group being set free in presence of a phenol, the development of an azo color takes place *pari passu*. This reaction is the basis of the process invented and patented by A. Feer. The photographic surface is a mixture of a diazo sulphonate with the alkali compound of a phenol applied to any suitable material. On exposure to light under a transparency, development of color takes place in proportion to the quantity of light transmitted, giving, therefore, a reversed reproduction, or negative picture. When printed, the unattacked mixture is dissolved away by copious washing, leaving the picture, already developed in the azo color, which is relatively insoluble, permanently fixed upon the fabric or material.

The process is not rapid enough to admit of being conveniently demonstrated by means of the artificial light at our disposal. We must therefore content ourselves with this brief description, referring those who wish for further information to the specification of the original German patent, No. 53,455/ga.

In concluding our brief sketch of this new departure in the application of the coal tar colors, we need not, perhaps, apologize for its brevity. We learn that our friend, Professor Meldola, is to give a course of Cantor lectures on "Photographic Methods;" and his survey of the field will be wide and complete. We have not attempted to give a general account of photographic methods partly on this account, and partly, also, because these diazotype processes are entirely typical of all printing processes, and, as subjects of lecture or educational demonstration, have the great advantage of involving the very simplest reaction possible; whereas, the changes which take place in silver compounds are very complicated, and as yet but imperfectly understood.

The primuline process is simplicity itself. It can be practiced with the minimum of apparatus, and requires no technical training. The results are striking and pleasing, as we hope to have been able to show.

We cannot conclude without a cordial expression of our indebtedness to the chairman, Captain Abney, for very valuable assistance in investigating the physical elements of the subject. The results we have only been able to glance at in a lecture of this scope. They will be dealt with in full at another time and place.

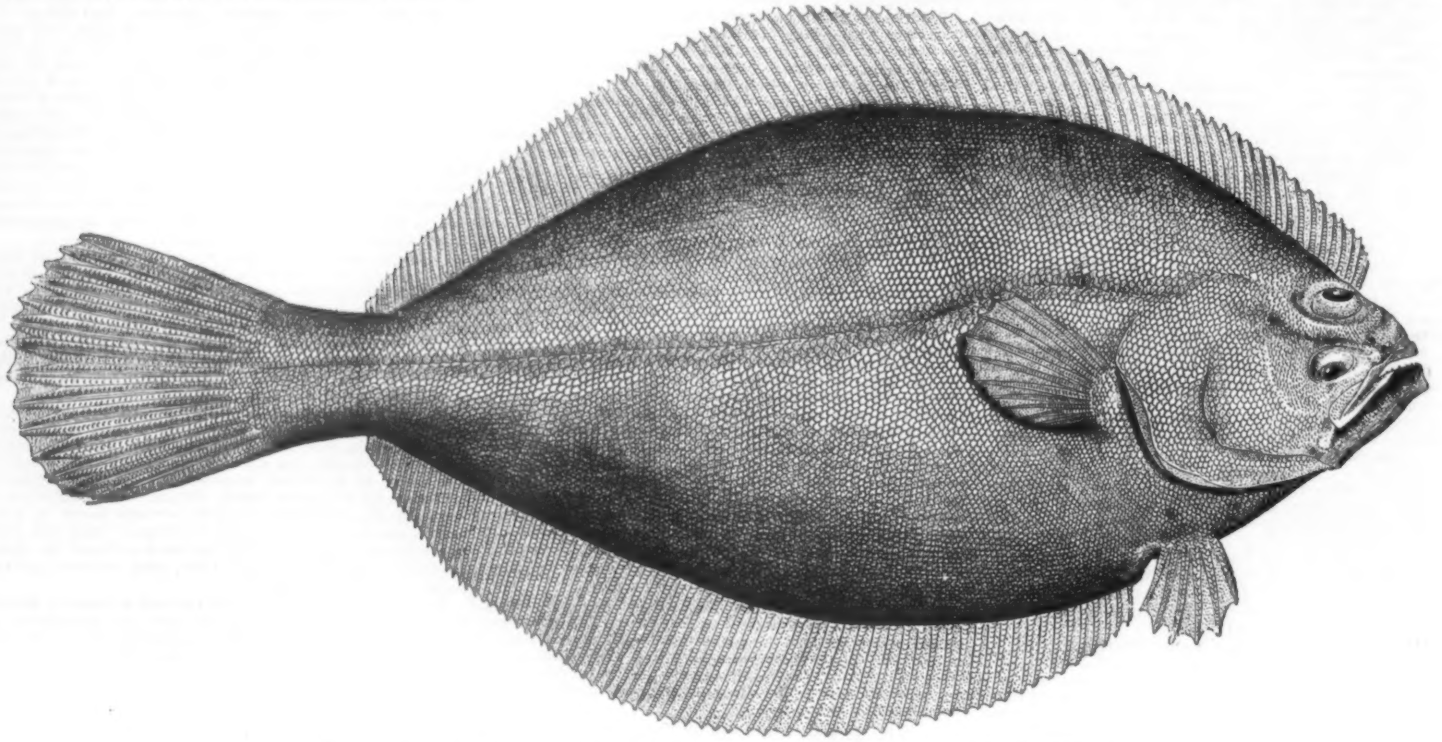
To the Autotype Company, through their manager, Mr. W. S. Bird, we would also express our thanks, for the loan of positives, and for other kind assistance.

In the discussion which followed, Mr. Cross said the yellow could not be entirely avoided with primuline. It was as essential to the product of decomposition by light as primrose yellow to the orginal primuline; but this was only the beginning of an entirely new development, and they had already succeeded in getting prints with other bodies

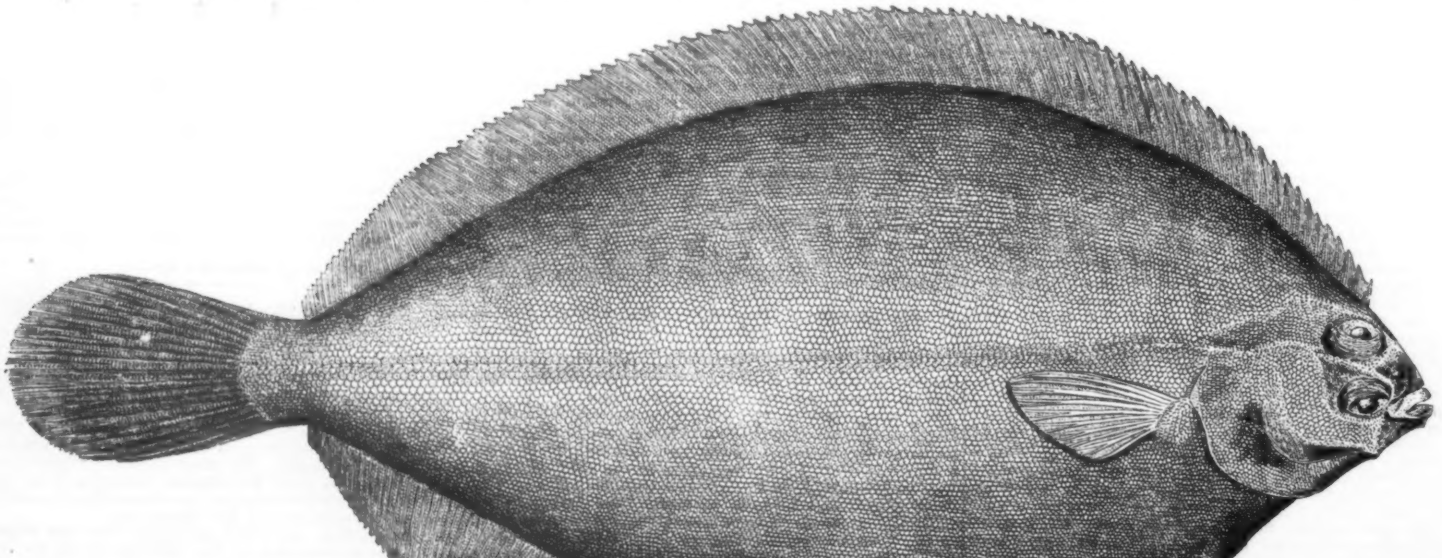
* Discovered by A. G. Green, in 1887. See "J. Soc. Chem. Ind.," 1888, 179.

of this class, which gave a very satisfactory approximation of the colorless ground which was such a desideratum for a large class of work. He did not quite understand the question how it was to be applied. They had printed from ordinary photographic positives; prints might also be taken from natural objects, such as ferns, leaves, etc., or an over-printed bromide print might be made transparent with vaseline, and it would yield a very satisfactory print. The applications were absolutely general, so far as photographic printing was concerned. It was for the future to decide what applications of it might be made by amateurs, ladies and others. The process was exceedingly simple; it required absolutely no technical training, and the minimum of apparatus. The fabrics would stand washing in boiling soap solution; and it seemed to him that here was an immense field open for the beautifying of dwellings, which it was for the public to make use of. Some of the prints exhibited were from glass positives lent by the Autotype Company; and a pretty wide range of objects had been selected. Primuline, as a dye, was invented two years ago, and had been used, to a large extent, by dyers; but its photographic application was a novelty. In conclusion, he had only to say that any one who was interested in the matter might obtain more detailed particulars by calling at his laboratory.

The chairman said he had worked a little with this process, and had been very much fascinated with it, and would recommend every one to introduce it to the ladies of their households, as a perpetual source of amusement, and a means of decoration. They knew how fond ladies were of occupying their leisure time in quasi-artistic pursuits of this character, and here was a method by which they could give a high decorative quality to their cushions and other articles by printing natural subjects upon them. They would be able to group ferns and leaves together into much more artistic combinations than the specimens which had been shown that evening, he had no doubt. The operation could be carried on, not, perhaps, in the drawing room, but in the parlor; the apparatus being very simple, and the materials harmless. They were much indebted to these gentlemen for bringing forward this subject. It was not every day that a new photographic process was brought forward, but this was absolutely new, and as a photographer he hailed anything which added to their knowledge of the means of producing pictures of any description. Unfortunately, it was not quite sensitive enough at present for the camera, but they could not say how far it might be developed. They had long been talking about photographing in colors, and something had been done in that way with carbon. This was not photographing in natural colors, but gave the means of producing prints in a great variety of tints, and without that nicety of manipulation which the carbon process required. He concluded by moving a hearty vote of thanks to the authors of this paper.



THE LEMON SOLE, OR SAND DAB. (HIPPOGLOSSOIDES PLATESSOIDES.)



THE COCK SOLE, OR POLE FLOUNDER. (GLYPTOCEPHALUS CYNOGLOSSUS.)

THE ADOPTION OF THE BEAM TRAWL IN THE UNITED STATES.

THE arrival at Boston, Mass., on March 30, of the beam trawling schooner Mary F. Chisholm marks a new era in the fisheries of this country, and is an event not unworthy of notice. Beam trawling, while quite a common method of fishing in England and Europe generally, particularly of the countries bordering on the North Sea, has never been adopted in the United States, because it was generally supposed that the fishing areas of New England were unfitted for its successful use. Heretofore, Americans have confined their labors to the use of hand lines, trawls or long lines, nets, etc., in the deep sea fisheries. From the success of the Chisholm, however, it is but fair to assume that this new method will be in almost general use in a few years.

The results obtained by the Chisholm are of interest to Americans in several ways. Not only does it prove that our waters are adapted to the use of the beam trawl, but also that a means is afforded for the capture of two species of fish not hitherto utilized, the pole flounder, believed to be identical with the cock sole of Europe (*Glyptocephalus cynoglossus*), and the lemon sole (*Hippoglossoides platessoides*).

Professor Goode, in his work on American food fishes,* speaks as follows regarding these species:

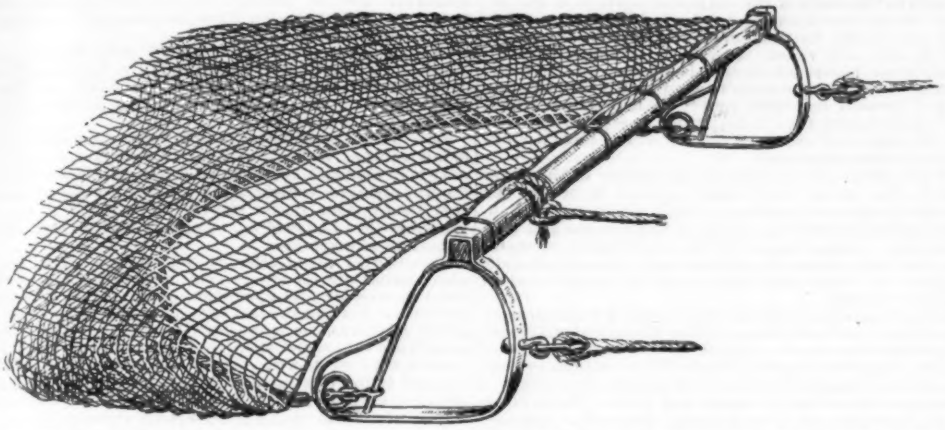
"The pole flounder, often known as the deep sea flounder, was first observed on this coast in 1877, when numerous specimens were obtained by the United States Fish Commission, in the deepest part of Massachusetts Bay. Specimens have since been obtained south of Cape Cod, at a depth of one hundred fathoms or more, by the Fish Commission, and Prof. Agassiz, off the entrance of Delaware Bay, at a depth of three hundred and ninety-five fathoms. The pole flounder appears to be a permanent resident, throughout the whole year, in the deep basins of Massachusetts Bay and on the edge of the continental slope, and is found abundant in Bedford Basin, the inner expansion of Halifax Harbor, at a depth of thirty-seven fathoms. It ranges nearly to Greenland, and is also found on the coast of Northern Europe, where it appears in Trondhjem Fjord, in latitude 65°, and south to the coast of Ireland. Its thermal range appears to be confined by the limits of 34° to 45°.

"It breeds abundantly in our waters in summer time. Numerous individuals, full of spawn, and young from half an inch upward, have been taken, from July to October, in various localities.

"The pole flounder has been pronounced, by all who have tasted it, a most delicious food-fish, resembling more closely than any other species on our coast the English sole, having a great quantity of peculiarly

* "The Fisheries and Fishery Industries of the United States." By G. Brown Goode and associates.

flavored mucilaginous tissue about the base of the fins. It has never been taken by our fishermen, because, on account of its exceedingly small and weak mouth, it could not hold fast to an ordinary hook and line, and, should it ever come into demand, it will be necessary for our fishermen to introduce the English trawl net.



TRAWL HEADS, BEAM, MOUTH OF NET, ETC.; SHOWS HOW BRIDLES ARE ATTACHED.

"The sand dab, or rough dab (which is the lemon sole of the North Sea), is taken in winter by the line fishermen of New England, and small quantities are, doubtless, brought to market and sold with other flat fishes without discrimination as to species. It often attains the length of twenty to twenty-four inches, and the weight of two to five pounds, and is, in all respects, a desirable food-fish, being highly esteemed on the other side of the Atlantic. In summer individuals of this species are to be found in very deep water, thirty fathoms or more, on the New England coast, and, though never very abundant in any one locality, might be taken in considerable quantities, in company with the pole flounder, by the use of a trawl net, or even by specially devised apparatus. Its breeding habits in our waters have not been observed, but in southern Sweden the spawning time is in April and May. It is a large-mouthed species, feeding upon fish as well as upon large invertebrates, such as crustaceans and annelids, and mention has been made of it more on account of its possible value in the future than for its present importance."

In his report for 1877, Professor Baird, then U. S. Commissioner of Fish and Fisheries, makes the following allusion to the probable utilization of the pole flounder:

"The reason that this fish has not been known hitherto is due to the fact that the beam trawl, the only apparatus by which it can be taken, is not in use on the American coast, as it is in Europe, for the supply of sea fish to the markets. . . . There is every reason to believe that in time this fish will become an important article of food in the Eastern markets; but for taking it the beam trawl must be employed."

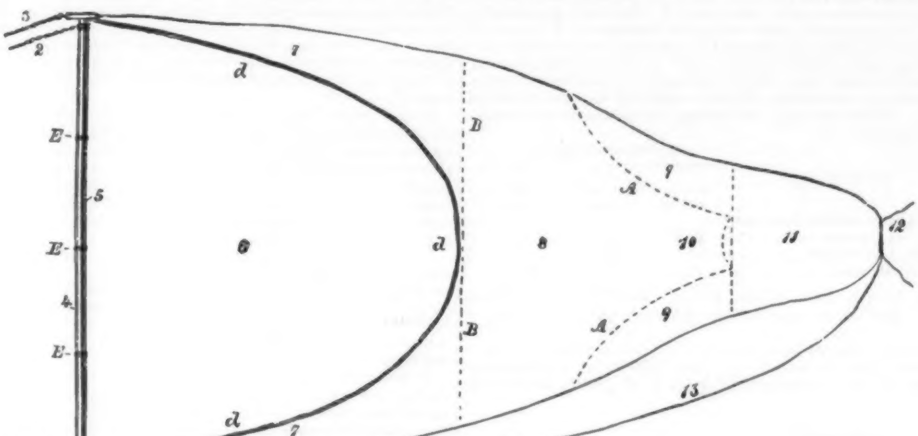
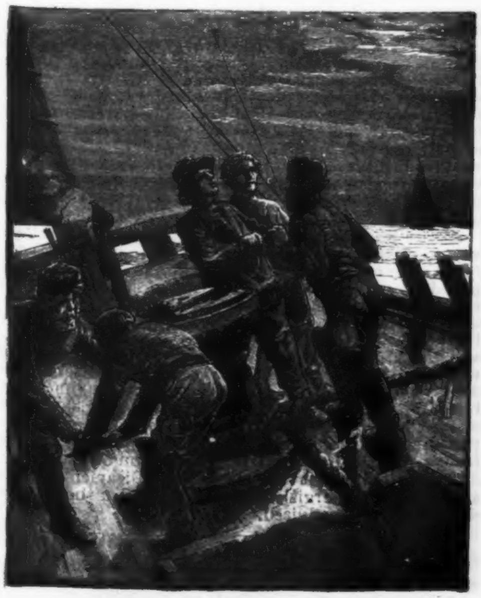


DIAGRAM OF BEAM-TRAWL.

1. Forward bridle.
2. Dandy bridle.
3. After bridle.
4. Beam.
5. Head line.
6. Square of net.
7-7. Wings.
8. Baiting on top, belly underneath.
9-9. Pockets.
10. Flapper.
11. Cod-end.
12. Poke-line.
13. Cod-line.

A, A. Where the net is sewed together to form pockets.
B, B. Where the square joins the baitings.
d, d, d. Foot rope.
E, E, E. Grommets.

During his stay in England, in connection with the exhibit of the U. S. Fish Commission at the great International Fisheries Exhibition in London, in 1883, Captain J. W. Collins took advantage of the opportunity to thoroughly study the method of beam trawling as practiced there. The results of his studies were embodied in a paper which was published in the Bulletin of the U. S. Fish Commission for 1888. The information contained in this work, and suggestions gleaned by a correspondence with the author, coupled with a previous experience in the fishery in Scotland, led the captain of the Chisholm to experiment with the beam trawl.



HEAVING IN THE TRAWL.

PACKING THE FISH.

Since the inception of the American bank fishery, the sole, owing to its peculiar anatomy, has been undisturbed by man; the hooks used by the fishermen being too large for its very small mouth. Thus, while other species have been continuously taken, the sole has remained, and now it will be possible to secure the large numbers of this species which are supposed to inhabit the offshore grounds.

In view of the great popularity of the sole in England, which these species are conceded to equal in flavor, it seems probable that a very brief time will be required to create a demand for them equal to the utilization of any amount which may be taken. In England it is not uncommon for sole to sell for as much as twenty five cents per pound, and frequently they are much higher. If Americans can get such fish at a much smaller price, there is certainly reason for gratification, and particularly should it be satisfactory in view of the fact that it utilizes species not heretofore attainable for commercial purposes and which are known to occur in great abundance. It is also a fact that there are thousands of miles of sea bottom, hitherto considered of little or no value as fishing grounds, where it is believed both the lemon sole and the cock sole can be secured in quantities.

A BEAM TRAWL.

In an interview the skipper of the Chisholm, Captain Alfred Bradford, gave the following interesting facts:

"We have had a good deal of bad weather, although we can work on a trawl in bad weather when other vessels cannot fish. On Tuesday, Wednesday, Thursday and Friday of last week we made hauls, in three of which we must have had at least two hundred tons or four hundred thousand pounds of fish. Why, think of it! In one haul the five and one-half inch dandy bridle broke under the strain of the great weight of fish which we were hauling in by the windlass. Some of the crew thought that we had rocks in our trawl, but this theory was disproved when the trawl neared the surface and large numbers of dead fish were seen floating to windward and live ones swimming out.

"We towed the trawl over one hundred and forty miles of ground and did not lose a mesh of twine. From latitude 41° 45' to the Capes of Virginia there is no better place in the world to drag our trawl. It is even better than the bottom of Dogger Bank in the North Sea. We fouled an anchor at one time, but when we hauled up the trawl we found it all right.

"It took us nine hours to haul in the trawl, in which time many of the fish died. What we want in order to prosecute this branch of the fisheries is steam and a good engine. With a good engine our trawl could be hauled in fifteen minutes and the fish would be taken alive."

In may be remarked that in England steam vessels are fast superseding the sailing trawlers. By the use of steam, vessels can come from and go to the fishing grounds and work their gear in calm as well as boisterous weather, whereas the sailing vessel depends entirely upon winds. If it be calm, sailing craft can do nothing, and in the rough gales of winter it is dangerous

for them to "shoot" their gear. For several years it has been customary to have sailing vessels remain at sea for weeks or months at a time engaged in towing the trawls, while a steam carrier made daily visits to the fleet and transported the catch to the market. But even this method has proved unsatisfactory. The financial return from steam trawlers has been so great that it has led to their general adoption, until now it is as much out of fashion to build a sailing vessel for trawling in England as it is in this country for a mackerelman to take his fare with hand lines.

Through the efforts of a prominent English designer and builder of yachts, small beam trawls, with nets of silk, have been introduced on many of the American yachts, and it will be quite a common thing during the coming summer to see a crack yacht "towing her trawl" on our coast.* E. C. BRYAN.

[FROM THE THERAPEUTIC GAZETTE.]

THE NEW MODES OF TREATING TYPHOID FEVER.†

By Prof. DUJARDIN-BEAUMETZ,‡ Paris, France.

GENTLEMEN: In the last lecture I spoke of the new modes of treating tuberculosis. I shall to-day take for my subject a disease which, next to pulmonary phthisis, is perhaps most frequently observed in ordinary practice. I allude to typhoid fever. In the treatment of this disease considerable progress has been made of late years, as I shall endeavor to show you.

I shall call your attention particularly to the antiseptic treatment of typhoid fever and to the employment of cold baths; and, lastly, to the prophylactic means available, in order to diminish the spread of typhoid fever.

If the knowledge of the *bacillus typhosus*, or bacillus of Eberth, has not yet given a complete explanation of the pathogeny of typhoid fever, it has, nevertheless, enabled us better to understand this affection and better to combat it.

As has always been the case in the discovery of the micro-organisms of disease, it is prophylaxis which has most profited by this discovery. We know to-day that the most active instrumentality in the propagation of typoid fever is the usage of waters which have been fouled by the dejections of typhoid patients, waters which become a culture medium favorable to these micro-organisms. In all the epidemics which we observe to-day, it is always in the water that we find the contagious element; this infectious agent we can cultivate so as to make its presence unmistakable; and in the remarkable discourse which Brouardel recently delivered at the Academy of Medicine (November 11, 1890), during the discussion on depopulation, you will find facts and statistics which make this mode of propagation no longer questionable.

Is this the sole means of propagation of the disease? It will by no means do to affirm this. In an excellent monograph on "Typhoid Fever in the Army," § Kelsch shows clearly the complexity of the factors concerned in this disease, and the divers conditions in which, either acting singly or in co-operation, they effect their result. To water, so often instrumental in conveying the contagion, we must add the accumulation of organic matters on the floor of barracks or in the holds of vessels; then telluric agencies, *i. e.*, the influence of the soil, as when the earth is dug up in the construction of the sewerage works of cities, and when in army life a large number of soldiers are obliged to camp on the ground. In his remarkable reports to the Academy, Lardier, of Rambervillers, has instanced undoubted cases of contagion and propagation of typhoid fever where the drinking water had no agency whatever.

So, then, while recognizing the fact that we have in contaminated water the most important factor of dothinenteritis, we must admit that there are other factors quite as active. Lastly, in order that the bacillus may develop, a favorable culture soil is necessary, and the best is that state of depression of the economy produced by overwork and exhaustion.

I have already had a good deal to say on this subject in my "Prophylactic Hygiene," and I have endeavored to show that if overwork brings about a typhoid condition and favors the development of the *bacillus typhosus*, the presence of the latter is necessary to characterize typhoid fever, and that it is important to distinguish the typhoid states due to overwork from typhoid fever proper, the first being the result of a blood poisoning—*i. e.*, the penetration of toxines in the economy—the second the result of an infection, or rather of a toxic infection, as the *bacillus typhosus* secretes a very active toxine, described by Brieger under the name of *typhotoxine*.

Prophylactic hygiene has utilized all these data, and we see to-day all our cities giving particular attention to the potable water of their inhabitants. This is a matter on which I had something to say in a previous lecture (see *Therapeutic Gazette*, 1889, p. 365).

From these data, which may be now considered as facts of science, there flow certain practical consequences to both public and private hygiene. Public hygiene is enlightened thereby as to the necessity of furnishing pure water to the inhabitants of towns and cities. As for the application of these facts to private hygiene, individuals everywhere recognize, or should recognize, the obligation to destroy as promptly as possible the dejections of persons affected with typhoid fever, and to disinfect all places fouled by these dejections.

So, whenever you are in the presence of a case of typhoid fever, you should formulate a series of precautions, to be rigorously observed by those whose business it is to attend on the sick, or to be much with them. For the disinfection of the stools, I would recommend particularly the sulphate of copper, of which you will have two solutions—one strong, the other weak. The strong solution contains 50 grammes (about 1⅝ ounces) to a liter (about 1 quart) of water; the weak, 12 grammes (about 3 drachms) to the liter. The first will serve for the stools, and you will see that the vessel which receives the dejections shall always contain a certain quantity of this solution. This same solution will serve, moreover, for the disinfection of soiled linen, and for the purification of the water closets.

The weak solution will be utilized for washing the hands and face of those who take care of the patient, as well as the parts of the cutaneous surface of the patient which have been fouled by his dejections. You will recommend to the nurses and attendants not to eat in the sick room. You will also advise them to wash their hands whenever they touch the patient. Lastly, it will be necessary to send to the disinfecting stoves (heated by steam under high pressure, which the municipalities are endeavoring to establish to-day in the different cities) all objects which have been in contact with the patient.

When people are not sure of the purity of the water which they drink, they ought to boil it, or use the sterilized water of commerce, which, owing to the facilities for its production, may now be procured at a very low price. Apparatuses for the sterilization of water are now very common; one kind much in use is portable, and can be transported at any time to the center of an infected district.

I do not speak of filtered water, and for this reason. The cylindrical water filters (called Chamberland filters) constitute an immense progress toward the obtention of water of absolute purity; but it is not enough to have simply the Chamberland filter; it must be perfectly well made, and free from all cracks and pores. These filters must, moreover, be kept perfectly clean—*i. e.*, exposed to a hot fire every week or two—a precaution rarely observed by persons who possess them, and who, confiding in the assertions of the dealers, believe that it is not necessary to cleanse the filter to have healthful water, which is a mistake. Lastly, there is a question much more grave—Do these filtering "bougies," which oppose the passage of microbes, offer a sufficient barrier to the toxines secreted by the microbes? This point has not yet been well demonstrated.

Boiled water presents none of these evils. Boiling destroys both the microbe and the toxines. It has been asserted that these boiled waters are indigestible; this objection has really little validity, and a recent work of Guinard has made this clear.* Guinard has shown that boiling really lowers the hydrotimetric † degree of the water of the Rhone and the Saone, but without depriving these waters of all their calcareous principles, though it does this with well waters; but here it is an advantage, as boiling rids the water of its carbonate of lime. Moreover, the following table shows you these differences:

Source of water.	Hydrotimetric degree.		
	Before boiling.	After fifteen minutes boiling.	Difference.
Rhone water delivered at Lyons	15·5°	12°	3·5°
Saone water	16°	11°	5°
Well water	52°	34°	18°

As for the gases of the water, ebullition, even when prolonged, does not completely expel them, and, moreover, the water very rapidly recovers these gases. The following figures, borrowed from Guinard, show this.

Before the action of the heat, 100 cubic centimeters of Rhone water contained 5·4 c. c. of gases, resolvable into

	C. C.
Carbonic acid	1·1
Oxygen	1·3
Nitrogen	3·0

After forty-five minutes of boiling, this water contained, still after cooling, 1·9 c. c. of gases, found to be

	C. C.
Carbonic acid	0·3
Oxygen	0·5
Nitrogen	1·1

The same water, after twenty-four hours of exposure to the air in an open place, had absorbed a new quantity of gases, and contained

	C. C.
Carbonic acid	0·3
Oxygen	1·1
Nitrogen	3·5

You see, then, that boiled water may redissolve a certain quantity of gases which it takes from the surrounding air. You see, moreover, that by prolonged boiling it is impossible to deprive water completely of its gases. So, then, in cases of doubt, advise the use of boiled water or of sterilized water.

I come now to the study of the new ways of treating typhoid fever.

The putridity of the intestines plays a considerable *role* in typhoid fever, and the denomination of *putrid fever*, formerly given to this affection, is perfectly correct in the light of modern researches.

This putridity results from the particular state of the digestive tube and the numerous ulcerations which develop there, resulting sometimes even in sphacelus of a portion of the mucosa. Hence the fetidity of the stools is a constant characteristic of typhoid fever. Physicians, of late years, have tried hard to counteract this putridity, and we are especially indebted to Bouchard for enlightenment as to the best means of intestinal antisepsis in typhoid fever.

Various agents have been tried. Bouchard first proposed charcoal, then iodoform, then naphthalin, finally naphthol, and it must be admitted that the latter agent is much superior to those first mentioned.

There are, as you know, two kinds of naphthol—one more soluble, less toxic, but more irritant, α naphthol; the other less soluble, more toxic, but less irritant, viz., β naphthol. It is to the latter that Bouchard has given the preference, and he associates the naphthol with salicylate of bismuth, under the form of powders or granules, and gives them in such a way that the patient shall take daily from fifteen to thirty grains of naphthol.

To-day, in my judgment, naphthol should be abandoned, and salol substituted in its place, and for this reason: Naphthol is always irritant; is often badly borne. Salol, on the contrary, is much better tolerated. Moreover, this salicylate of phenol is a medicament which is not decomposed until it reaches the intestines.

It is the disinfectant *par excellence* of the intestines, and has been so far useful from this point of view, as in patients afflicted with artificial anus, to do away with one of the most serious inconveniences attending that infirmity by destroying the odor of the fæcal matters constantly flowing through the fistulous opening. It is, then, to salol that you should resort, and I add that salol is but slightly toxic.

In some experiments made in 1887 with Dubief, and detailed in the thesis of my pupil, Dr. Lombard,* we demonstrated that it is necessary to give to a rabbit salol in the proportion of one gramme per kilogramme of weight to produce death.

Salol has an odor which is sufficiently agreeable; not being soluble, it has no savor; and you can administer it in capsules, or, what is better, in suspension in an appropriate vehicle. The quantity to be given in the twenty-four hours should be between 2 and 4 grammes (½ to 1 drachm). You can add, if you wish, salicylate of bismuth.

To practice disinfection is not enough. You must also combat the febrile element, and this is one of the most interesting and important points in the question before us. During the last few years a great number of active antipyretic agents have been discovered, which constitute that series of antithermic medicines of which I have so often spoken. These medicaments have been applied to the treatment of typhoid fever, and we see a great number of our *confreres* attribute to them a real value. I confess that I cannot share this confidence.

The hyperthermia in dothienteritis is but one manifestation of the general state of the patient, and to believe that in lowering the temperature you are going to get rid of the gravity and intensity of the disease is a profound mistake. We see, on the one hand, very grave cases of typhoid fever without hyperthermia; and on the other hand, we can, by our antithermic medicines, keep down the temperature of the patient to the normal during the entire course of the disease without diminishing for an instant the gravity of the affection. If I add that the most of these antithermics diminish the urinary secretion, and thereby oppose the elimination of the toxines which are produced in so great quantity by the febrile state, we shall have, I believe, sufficient reasons to be very reserved in the administration of these antithermic analgesics in typhoid fever, and I fully agree in this respect with Cantani in his communication made to the Berlin Congress.†

Ought we to have the same reserve in respect to the employment of cold baths—of tepid baths? As for cold baths, I have many times given my conclusions as to their therapeutic value, both in my "Clinical Therapeutics"‡ and in this journal,§ and the recent facts which our colleagues of the hospitals have communicated, and in particular Juhel-Renoy, Merklen, Josias, etc., have not modified my opinion.

The cold bath is a good therapeutic agent; it not only opposes the hyperthermia, but especially the disturbances of the nervous system. What I have especially combated is the systematization of Brandt's method; and I shall return to this point by and by when I come to speak of the statistical results of the different methods of treatment employed.

If you do not see me prescribe cold baths as a routine measure of practice in my hospital, it is because I find in lotions, wet packings, and especially in tepid baths, the same advantages as in cold baths, without the inconveniences of the latter. Tepid baths constitute an excellent method of treatment in typhoid fever, and by tepid baths I mean such as have a temperature of 30° to 32° C., and present a difference of about 10° from the body temperature of the patient. I obtain with these tepid baths sedation of the nervous disturbances, a sufficient fall of the temperature, and a state of freshness of the skin, and general comfort, which enables the patient to get the needed rest. This is the order that I generally follow when prescribing baths and ablutions:

I begin by lotions; then, if the temperature exceeds 40° C., I give tepid baths, one or two a day, according to the thermometric indications; the duration of the bath should be from 20 to 30 minutes, and, when the patient is feeble, I give him stimulating drinks while he takes his bath. If a very intense ataxo-adynamia supervenes, I wrap the patient in a wet sheet. The duration of this wet wrapping should never exceed thirty seconds.

To terminate what pertains to the fever, I shall speak of sulphate of quinine and of benzoate of sodium. Of all the medicaments applied to typhoid fever, sulphate of quinine has the best withstood the attacks which have been made against the pharmaceutical treatment of this disease.

If we have abandoned the large doses of quinine and content ourselves with only medium doses, amounting to one gramme per day, we none the less consider quinine as one of the best medicaments ever used in typhoid fever; and we see certain of our colleagues, Grancher in particular, maintain that the salts of cinchona have an action really specific in dothienteritis, especially when this disease affects children. I do not altogether adopt this view. At the same time I recognize that quinine is a medicine which finds its place in a great number of cases of typhoid fever.

Albert Robin has shown himself the most earnest advocate of the use of benzoate of sodium in typhoid fever. He has, in fact, proposed a new theory of typhoid fever based on the following circumstances: In typhoid fever there is not augmentation but diminution of the oxidations, with exaggeration of organic disintegration. The oxidations, as I have said, are lessened, and this hinders the combustion or modification of the waste matters which result from the increase of the disintegration. Moreover, the different emunctories being affected, the toxines and the waste elements of disintegration incumber the economy. According to this theory, the crises, favorable or unfavorble, result from either the more active elimination of these products or their retention. Hence all medicaments which are capable of energizing the combustion of the organic *débris* should be advised.

* The illustrations of the beam trawl and trawling operations have been taken from the admirable treatise on the subject by Captain J. W. Collins, "The Beam Trawl Fishery of Great Britain," etc., published in the Bulletin of the U. S. Fish Commission for 1888.

† From advance sheets, revised by the author (translated by E. P. Hurd, M.D.) Lectures delivered in Cochin Hospital, Paris, France.

‡ Member of the Academy of Medicine, Physician to the Cochin Hospital, Paris.

§ *Revue d'Hygiene*, August and September, 1890.

* Guinard, *Lyon Medicale*, August 10, 1890.

† The *hydrotimeter* is an apparatus for the qualitative and quantitative analysis of water. It determines the quantity of the lime salts by the aid of a solution of soap (Robin).—Tr.

* "Researches on Salol" (*These de Paris*, 1887).

† Cantani, Congress of Berlin, 1890, and *Bulletin General de Therapeutique*, t. cxiv., 1890.

‡ "Clinical Therapeutics," Detroit ed., art. "Typhoid Fever."

§ *Therapeutic Gazette*, 1887, p. 803.

Robin mentions especially salicylic and benzoic acids; he gives daily 30 grains of benzoic acid or 60 grains of benzoate of sodium. I do not know that the method of our colleague has come into very general use, and if salicylic acid and the salicylates are still prescribed, it is rather that they may act as disinfectants. As for benzoic acid and its derivatives, it is but little employed.

All these means of which I have just spoken may furnish two orders of therapeutic agencies—the one systematic, *i. e.*, applicable to all cases; the other, to be applied according to indications.

Certain authorities have systematized the cold baths; others, like Bouchard, antisepsis, with the tepid baths; others employ only the salicylate of bismuth, etc. I am a thorough opponent of systematization.

For a disease like typhoid fever, which presents itself under the most variable forms, we cannot admit a therapeutic formula which applies indiscriminately to all cases, and our treatment should vary according to the patient whom we have before us. We may truly say that there is no treatment of typhoid fever, but a treatment of typhoid patients, and this I shall endeavor to prove to you by the recent statistics furnished by the practice of our Paris hospitals.

In a very interesting communication made by Merklen* to the Society of the Hospitals, on the results of the divers treatments of typhoid fever in the hospitals of Paris, you will find statistics of great value, and the first point to which I would call your attention is that, taken in its entirety, the mortality varies according to the periods; sometimes it rises, sometimes it falls. Thus, in the period extending from 1868 to 1882, the mortality in the hospitals from typhoid fever was twenty-one per cent. From 1882 to 1888 it fell to fourteen per cent., and in 1889 it was thirteen per cent., and this whatever kind of treatment was employed. We may even say that in 1890 it is still lower, being not more than twelve per cent.

This mortality does not affect equally both sexes, and as Hayem has remarked, the figure of the mortality of women is much larger. Juhel-Renoy makes this difference—viz., twelve per cent. for women, five per cent. for men. The mortality of women, then, is more than double that of men.

Has the treatment, then, any influence on this fall of mortality? The difference is very slight, that is, as far as our hospitals are concerned.

If we take as the basis, for instance, the year 1889, we find for the total mortality—military hospitals, general hospitals, and children's hospitals—with the symptomatic treatment, 11·33 per cent.; and with the systematic treatment by cold baths, 11·28 per cent. The lowest mortality was obtained in 1889 by the combined employment of quinine and tepid baths, being 7·33 per cent. But Debove has shown how careful we should be in drawing such conclusions, since by almost absolute expectancy, only a hygienic treatment being employed, the practitioner at the Hospital Andral has had a mortality of only 9·2 per cent.†

Moreover, in a recent communication, Merklen has brought clearly to view a fact on which I had long dwelt in my "Clinical Therapeutics," viz., the difficulty of basing therapeutic conclusions on statistics, and you will permit me to repeat what I said ten years ago in the first edition of that work. After citing the remark of Forget—"Statistics are like an obliging girl who gives herself up to the first comer—I added, with reference to typhoid fever, "Do you believe that one typhoid patient is exactly like another typhoid patient?" The age of the patient, the state of his vital forces, the relative severity of the epidemic, the period of the year, the nature of the locality even, have a great influence on this pathological aggregate, and modify its march and its fatality. It is here especially that we see the influence of what I have called the morbid genius of epidemics, where one sees epidemics relatively benign succeed epidemics that were relatively malignant; and according as you employ the same method of treatment to the first or to the second, you will have supplied multiplied successes or failures.‡

I find a confirmation of these views in the discussion which took place at the Society of the Hospitals, where Merklen showed the variations of the mortality according to epidemics.§

With regard to this variable mortality of epidemics of typhoid fever, is it in contradiction with the recent data which we have acquired concerning this disease? By no means. What, in fact, does bacteriology show us? It puts in clear light this fact, that the virulence of the products secreted by the microbes is variable according to multiple circumstances, and it is probable that under certain conditions, of which the knowledge still escapes us, the *bacillus typhosus* acquires extraordinary virulence. If, we add, in accordance with the teachings of Koch, the gravity varying according to the soil on which this microbe is cultivated, debility of the organism, overwork and exhaustion, insufficiency of alimentation, etc., we shall have the explanation of this variation in the mortality by typhoid fever, which we have before ascribed to the "morbid genius," confessedly a vague and indeterminate word.

What conclusions shall we draw from all this? This—namely, that nothing in the facts of the case warrants the advocates of systematic medications in affirming the superiority of their method over the symptomatic modes of treatment, and that here, as in many other things, it is the attention which the physician shall give to the patient whom he treats, it is the promptness and the rigorousness with which the treatment shall be applied, it is the celerity with which he shall combat the varied symptoms which appear in the course of typhoid fever, which constitute the success of the treatment employed, whether the latter be systematized or not.

But, however important the part which you may assign to this systematization, do not forget that there are still three elements of success which ought always predominately to enter into your therapeutics—the disinfection of the intestinal contents, the promotion of an abundant diuresis, and a most scrupulous attention to the hygienic needs of the patient.

* Merklen, "The Treatments and the Mortality of Typhoid Fever in the Hospitals of Paris" (*Bull. et Mem. de la Soc. des Hop.*, July 9, 1890, p. 628).

† Debove, "On the Mortality from Typhoid Fever" (*Bull. et Mem. de la Soc. Med. des Hop. de Paris*, July 25, 1890).

‡ "Clinical Therapeutics," G. S. Davis, Detroit, Mich., p. 381.

§ Merklen, "The Variations in the Mortality of Typhoid Fever" (*Bull. et Mem. de la Soc. Med. des Hop.*, October 30, 1890).

As to the first point, I need not repeat what I have already said. Salol is the medicament which seems to me best to fulfill this indication.

As for the matter of diuresis, I adopt in this regard the views of Albert Robin, and believe that it is useful to favor as much as possible the elimination of the products of organic disintegration; and as the most active channel for this elimination is the kidney, it is necessary to give our patients abundant drinks to favor diuresis. I believe even that the success obtained by Debove by expectancy is due to the fact that he always requires his patients to drink abundantly. Unhappily, in grave cases, the bad condition of the mouth, and the fuliginosities which encumber it, joined to the state of prostration and delirium into which the patient is plunged, often render the administration of beverages very difficult. The drink which I prefer is fresh vinous lemonade, which may be iced if one wish.

Lastly, this great question of hygienic attentions dominates the entire therapeutics of dothinenteritis, and explains the marked difference which exists between the mortality of the hospitals and that of private practice. Despite the painstaking and devotion of our hospital nurses and attendants, it is impossible to give our patients in those public institutions the scrupulous attention which we can exact in private practice, especially among rich people. In private practice, such factors as the ablutions, the constant cleansing of the mouth, the disinfection of the excreta, the excellent ventilation of the sick room, the plentiful supply of nurses—new and fresh ones taking the place of those that are tired out, and the patient never being left an instant unattended—all this constitutes so many chances of success, which gives the patients of the better classes in private practice the advantage over hospital patients.

Such are the considerations which I desired to present in connection with the treatment of typhoid fever. They show on this special point the indubitable progress of therapeutics. In the next lecture, which will finish the conferences of this year, I shall take up a subject on which there has been a great deal of discussion of late, and which may be considered as being yet far from settled. I refer to "Hypnotic Suggestion in Therapeutics."

DIPHTHERIA GERMICIDES.

IN a communication upon the therapy of diphtheria, Professor F. Loeffler has put on record the results of experiments made to determine the relative effect upon the characteristic bacillus of a very large number of substances that have been recommended for the local treatment of that disease (*Deutsch. med. Wochens.*, March 5, p. 353). The method adopted was to allow the substance in solution or as vapor to come into contact with a blood serum mixture inoculated with the bacilli of diphtheria. This was done both soon after the inoculation, while a "sowing" was still superficial, and when a "cultivation" had had time to develop, since it was found that the same substance, or even the same degree of concentration, was not always equally effective in both stages.

It was found that of the inorganic compounds a solution of corrosive sublimate 1 in 10,000 destroyed instantaneously all the germs in a superficial sowing, and one of 1 in 20,000 left comparatively only a few germs intact, but from these vigorous colonies developed in a day or two. This agent, however, produced essentially less effect upon a cultivation, a solution of 1 in 2,000 not penetrating to the deeper layers of bacilli in twenty seconds; one of 1 in 1,000 left very few germs undestroyed at the end of twenty seconds, and with still stronger solutions the work was complete. Mercuric cyanide proved less effective, the germs on a sown serum surface being first instantaneously destroyed by a 1 in 800 solution, while it required a 1 in 200 solution to kill all the germs in a cultivation in twenty seconds. Silver nitrate solution of less strength than 1 in 150 was insufficient to render a superficial sowing sterile, while it was without effect upon a cultivation in twenty seconds. Silver chloride dissolved in sodium hyposulphite was practically not much more effective. With potassium permanganate a 2 per cent. solution sterilized a surface sowing, and a 5 per cent. solution a cultivation in twenty seconds. Potassium chlorate (5 p.c), saturated lime water, hydrogen peroxide (1 p c.), sulphuric acid (2·25 p.c.), formic acid (1 p.c.) and lactic acid (1 p. c.) were perfectly inactive in ten seconds' contact. Iodine in aqueous solution was inactive, but iodine 5 parts and potassium iodide 10 parts in water 300 parts killed cultivations in twenty seconds. Bromine in 1 in 1,000 solution acted powerfully upon a sowing, but only a saturated solution (2·5 p. c.) killed cultivations in twenty seconds. Chlorine water (1 in 1,100) killed sowings in ten seconds, and ten times that strength sterilized cultivations in twenty seconds. A saturated filtered solution of chloride of lime was equally effective upon cultivations, while it still destroyed superficial sowings when diluted twenty-five times. Iodine trichloride in 1 in 1,000 solution sterilized sowings, but did not produce the same effect on cultivations with certainty in 1 in 100 solution.

Of organic compounds, absolute alcohol destroyed sowings by momentary contact almost completely, but a 50 per cent. by volume spirit showed quite a weak action. Ether behaved similarly. A mixture of alcohol 50 parts, ether 25 parts, and water 25 parts, was very effective in ten seconds contact. Cultivations were sterilized by absolute alcohol or by ether in twenty seconds. Allyl alcohol, which in extraordinary small quantities inhibits the growth of the anthrax bacillus, showed in 5 per cent. solution only a slight effect upon sowings of the diphtheritic bacillus in ten seconds. Benzyl alcohol, on the other hand, in aqueous solution sterilized the surface with certainty in ten seconds, and chloroform water showed itself remarkably active upon sowings. Carbolic acid was in 1 per cent. solution inactive; in 2 per cent. solution it showed a distinct action; but it first became capable of destroying sowings instantaneously in 3 to 4 per cent. solution. By the addition of 30 to 40 per cent. of alcohol the action of a 2 per cent. solution was rendered complete. Cultivations were completely sterilized by 5 per cent. solution of carbolic acid in twenty seconds, and if 30 per cent. alcohol were used as a solvent the same effect was produced by a 3 per cent. solution. Lysol in 2 per cent. solution sterilized sowings in ten seconds, but in its effects upon cultivations it came far behind carbolic acid. The three methyl phenols, *o*, *m*- and *p*-cresol, approximated closely to carbolic acid in their action, and resembled it in the concentration effective against sowings being near to that effective against cultivations. The cresolsulphonic acids proved to be much less effective than the phenols, and the same may be said of salicylic acid. Of the three dioxybenzols, resorcin was least effective, a 10 per cent. solution not sterilizing a sowing in ten seconds; pyrocatechin came next, and hydroquinone is thought worthy of further experiment. The trioxybenzol phloroglucin showed in 2 per cent. solution a slight action, but a saturated aqueous solution of tropæolin was without effect.

A large number of essential oils were also tested as to their action upon the diphtheritic bacillus, the plan adopted being to moisten with the oil to be tested the under surface of the wadding placed in the neck of the flask containing the inoculated serum mixture, and closing the whole with an India-rubber cap. The oils showed a remarkable difference in their behavior, for while some hindered more or less the growth of the bacilli, others seemed actually to favor it. With the oils of sweet orange peel, lemon, eucalyptus, spike, thyme, mustard and garlic, as well as with allyl sulphide and anhydrocoriander, a substance prepared from coriander oil, no growth was perceptible in the flasks after two days. But upon removal of the India-rubber cap, development of the cultivation commenced in all the flasks, except that containing allyl sulphide, the growth taking place mostly at edges of the drops of condensed water. Since these results appeared to point to the activity being due to hydrocarbons, the experiments were continued with a number of hydrocarbons of the aromatic series and their ethers.

These were benzol, anisol, phenetol, toluol, *o*-, *m*- and *p*-xylol, pseudocumene, cymene, cumene, thymol, creosol and oil of turpentine. All these bodies, except solid thymol, a piece of which was fastened under the India-rubber cap, and creosol, showed a remarkable inhibitory action, which with some was not limited to the surface, but penetrated deeper, as was shown by the non-development when the serum was inoculated by puncture. Anisol, phenetol, toluol and benzol proved especially active, since the surface of the serum in those flasks remained sterile after removal of the caps. It follows that the germs must have been killed by the vapor of these substances. When, however, one of these substances was poured upon a cultivation, it did not by twenty seconds' contact destroy its power of development, and the action was not increased by an addition of alcohol.

On the other hand, while thymol vapor was inactive, a 1 in 500 solution of thymol in 20 per cent. alcohol destroyed sowings almost immediately, and aniline, which was also without effect in the vapor form, was very energetic when mixed with water. The vapor of metallic mercury also was fatal to sowings.

From the foregoing results, the author arrives at the conclusion that for prophylactic purposes, when there is danger of infection, the best of all treatment consists in using as a gargle for five or ten seconds every three or four hours a 1 in 10,000 to 1 in 15,000 solution of mercuric chloride, or, perhaps better, a 1 in 8,000 to 1 in 10,000 solution of mercuric cyanide, because of its less disagreeable metallic taste.

Other gargles that might be used with advantage are those of chloroform water containing only a small quantity of chloroform, chlorine water containing 1 part of chlorine in 1,100 of water, or a solution of 1 part of thymol in 500 parts of 20 per cent. alcohol. Of the substances active in the vapor form might be used the oils of sweet orange peel (oil of Portugal), lemon, eucalyptus and spike, as well as anisol, phenetol, benzol, and toluol.

In the treatment of actual cases of diphtheria Dr. Loeffler considers that, in addition to gargling every two hours with one of the above named weaker solutions, a gargle of one of the stronger preparations, shown to be capable of sterilizing cultivations, might be used every three or four hours. Which of them is most suitable will have to be determined by actual experiments, but the author suggests a 1 in 1,000 solution of mercuric chloride, a 3 per cent. solution of carbolic acid in 30 per cent. alcohol, or alcohol and oil of turpentine each with 2 per cent. of carbolic acid.—*Pharm. Jour.*

COCOA-NUT BEETLES.

THE destruction of cocoa-nuts in the Straits settlements by insects has been so great that of late much attention has been given to the question. Perhaps the most important contribution that has yet been made to our knowledge of these pests is a recent report by Mr. H. N. Ridley, director of forests and gardens, Singapore, on the destruction of cocoa-nut palms by beetles, which has been printed by the government and issued from the colonial secretary's office. There are, Mr. Ridley says, two species of beetles which are especially destructive to cocoa-nut palms. The first is the *Oryctes rhinoceros*, commonly known as the rhinoceros, elephant, or black beetle, and the other the *Rhynchophorus ferrugineus*, known as the red beetle. Two other larger species of Calandra attack some palms at Singapore, but Mr. Ridley has not received any notice of their attacking cocoa nuts.

The *Oryctes rhinoceros* belongs to the group of Lamellicornia. The parent beetle usually deposits its eggs in decaying cocoa-nut trees. The identification of the larvæ is very difficult, for the grubs of all the larger Lamellicorn beetles are very much alike. The larva is white and fleshy, and when full grown is about three inches long; the head is round and hard, and is of a dark chestnut color. It is covered with short bristles, the legs are about half an inch long, the antennæ are short and hairless, and the jaws thick and strong. The chrysalis has the form of the perfect insect, but the insect is very rarely found in this state. The beetle itself is sometimes two and a half inches long; it is very broad, and is of a dark brown or black color, and its chitinous coat is very hard. The head of the male is small, and has a horn, about half an inch long, curved toward the back. The wing cases do not quite cover the body, they are broad and oblong, and covered over with minute punctures. The legs are strong, and the second joint is armed with teeth, by means of which the beetle cuts its way into the tree. The female is usually much smaller, and is readily distinguishable from the male. The grub is quite harmless, but the

perfect insect is most destructive. It always works at night, attacking the base of a leaf stalk, burrowing into the heart of the cabbage, where, as a rule, it remains all the next day. The attack is generally renewed till the rain finds its way in and rots the palm. The destruction of the tree is hastened by the fact that when once a tree has been attacked it appears to become popular. Besides the cocoa-nut palm, very many other palms, a list of which is given by Mr. Ridley, are destroyed by this insect, but, so far as is known, it does not attack other trees. The present methods adopted for destroying the *Oryctes rhinoceros* are described and criticised in the report. The usual mode is to search for the beetles in the palms, and spear them with a flexible iron wire. Large fires are also made in the plantations at night, and the beetles flying toward the light are beaten into the flames by men and boys with branches of trees. Mr. Ridley does not hope to exterminate the pest, but he thinks that its numbers can be greatly reduced by destroying in all the plantations rubbish and vegetable refuse of all kinds. Dead trees should be burnt, and the law should prevent any planter from allowing any heap of vegetable matter, in which the insects always breed, accumulating, and also from keeping any dead trees on his land. By this simple measure the ravages of the beetle can be minimized, if not quite abolished.

The second species of beetle spoken of in this report is the *Rhynchophorus ferrugineus*, the red beetle, which is, perhaps, even more destructive than the other. In the case of *Oryctes rhinoceros*, it is the perfect insect which is destructive; in the present instance it is the grub. It attacks the trees at night, and having perforated the base of the leaf stalk, it pushes the egg deeply into the body of the tree. The grub is white and footless, and tunnels through the soft portion of the palm. Unfortunately the presence of this insect in the tree is not so easily detected as in the former case. The grub is a thick, cylindrical, white larva, without feet or antennæ. The head and jaws are small, and the body curved and wrinkled. The perfect insect is usually about two inches in length. The head is small and usually red; the wing cases are black, sometimes ornamented with red, and a good deal shorter than the body. The legs are black and long, and have a strong claw at the end of the second joint, and two small ones on the feet. The methods of destruction used by the planters are very similar to those used in the case of the rhinoceros beetle, but on 'account of the difficulty of tracing the red weevil they are not so efficacious. If the black beetle is much reduced in numbers, the effect will be to reduce the red beetle also very much, for the latter will not then be able to take advantage of the holes which have already been made by the former. In dealing with this beetle also, the report urges the necessity of making the destruction of all vegetable refuse compulsory, particularly in the neighborhood of the palm plantations.

SIMPLE SCIENTIFIC EXPERIMENTS.

A WRITER under the *nom de plume* of Tom Tit has been publishing in *L'Illustration*, under the title Amusing Science, a series of experiments that are easily performed by means of common objects. Some are simple diversions, while others, on the contrary, constitute true scientific demonstrations, and it is on this account that we propose to present them to our readers.

The candle that burns in water (Fig. 1) is an ingenious application of the principle of Archimedes. Weight a piece of candle by inserting a nail in the lower end, so that, while the candle is floating vertically in a glass of water, the liquid shall be flush with the edge, without, however, wetting the wick. Light the wick and announce to the spectators that the candle is to burn to the very end in this new-fangled candlestick. Your assertion will be received with much incredulity, but the onlookers will be forced to surrender to the evidence.

The candle will shorten in burning, it is true, and it would seem as if the flame would have to come promptly into contact with the water, but to the candle's diminution in bulk there corresponds a diminution in weight, and it rises in the liquid in measure as it is consumed.

In addition to the amusement that it affords, this experiment presents a practical side. Contrary to what occurs with a candlestick, where the flame of the candle continues to descend, the floating candle will present a luminous point of invariable height, which will permit of its being used for photometric experiments.

The eruption of Vesuvius (Fig. 2) recalls to us in a picturesque manner the law of superposition of liquids at different densities.

At the bottom of a jar full of water place a small bottle containing red wine, and the cork of which is provided with an aperture. The water will gradually

FIG. 1.—CANDLE BURNING IN WATER.

expel the wine, which will escape in a thin red stream and spread out at the surface. By means of plaster, or simply of a little earth, imitate at the bottom of the vessel a small mountain to conceal the bottle, and form an aperture at the top corresponding to the one in the cork, and you will have before your eyes a volcano, and the wine escaping in a reddish jet will give you an idea of an eruption of the same.

The unequal density of liquids will permit us to change water into wine. (Fig. 3.)

Fill two goblets that are exactly alike with water by immersing them in a pail and place their rims against each other before taking them out of the liquid. Place them upon a plate thus superposed, in preventing the entrance of air between their rims.

Upon the foot of the upper goblet, which is turned upside down, place a wine glass containing claret wine into which dips a bit of wool that hangs down externally and acts as a siphon.

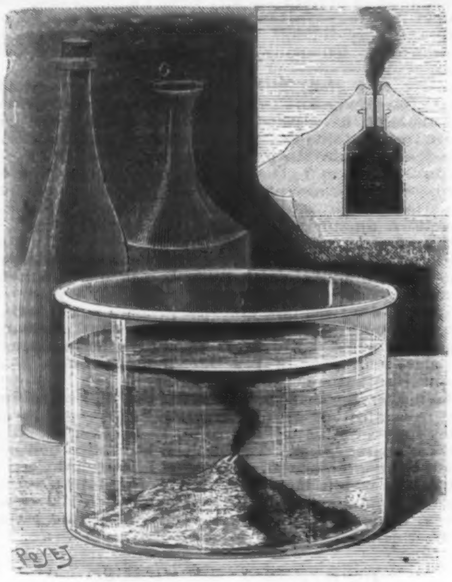


FIG. 2.—ERUPTION OF A VOLCANO.

These preparations made, one has only to observe what will take place. The wine, falling drop by drop from the wool, will fall over the sides of the upturned goblet, and then, having reached the junction of the rims of the two goblets, it will, as if by suction, be drawn between the two rims by an effect of capillarity, and will ascend toward the bottom of the upturned goblet, the water in which it will color red, while the lower goblet will remain full of pure water.

As may be seen, there is nothing more simple than this experiment in the transformation of liquids. "Amusing Science" points out to us a number of other experiments that we cannot describe here. We shall be content to mention a few of them; the immersion of a lump of sugar without wetting it, an experiment demonstrating the principle of the diving bell, the measurement of the force of the breath by substituting a simple paper bag for the spirometer or other analogous apparatus, the piercing of a pin with a needle, etc.

We cannot leave the subject of optics without saying a word in regard to a curious experiment upon

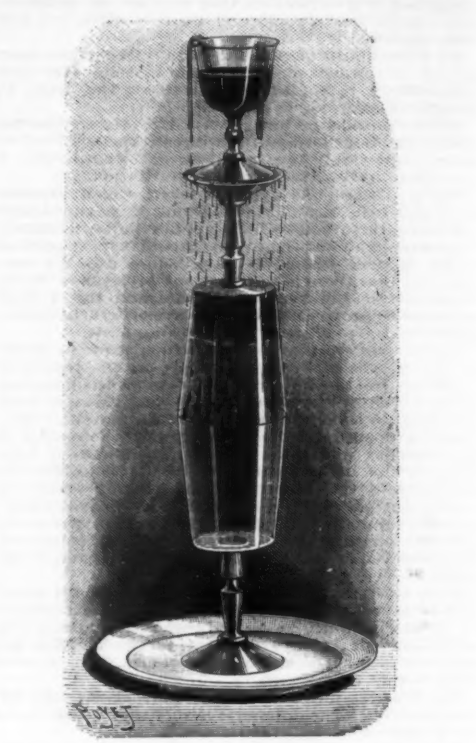


FIG. 3.—WATER CHANGED INTO WINE.

complementary colors. A small card board figure (Fig. 4) is placed vertically between a screen and two candles that are situated at an equal distance.

The figure projects upon the screen two distinct shadows of equal intensity. Now interpose between the screen and the candle to the right a piece of red colored glass, or, more simply, a glass of water colored red, and you will observe the shadow to the right to assume a dark red color, while that to the left has disappeared and been replaced by a pale green figure that stands out from the screen, exhibiting a rosy tinge. If the experiment be carried further, the figure to the left will always be of the color complementary to that of the liquid contained in the glass. Beer, which is yellow, will give a violet figure, water colored with blue ink an orange figure, etc.

FIG. 4.—EXPERIMENT ON COMPLEMENTARY COLORS.

FIG. 5.—REVOLUTION OF THE EARTH.

Reverse the experiment and put successively into the glass a green, violet and orange liquid (for example

absinthe, violet ink and curacao), and the color of the image on the screen will be in turn red, yellow and blue. In conclusion let us mention the experiment that the author designates the revolution of the earth (Fig. 5).

After eating an egg *à la coque*, carefully preserve, without breaking it, the small piece of shell that has been removed from the egg in order to open it. Moisten the rim of a plate with a little water, place the piece of shell thereon, and, by an imperceptible motion of the wrist, tilt the plate in giving it a proper oscillatory motion. The shell will be seen to revolve rapidly while moving around the plate, thus exactly recalling the double motion of the earth.—*Le Genie Civil.*

SINKING OF THE UTOPIA AT GIBRALTAR.

THE sinking of the steamship Utopia in the Bay of Gibraltar, by collision with H. M. S. Anson, causing the loss of over 560 lives, is one of the most terrible disasters. It occurred on Tuesday, March 17, at 7 o'clock in the evening. The Utopia, belonging to the Anchor line, was an iron screw steamer of 2,731 gross tons, built at Port Glasgow in 1874, and was owned by Messrs. Henderson Brothers, of Glasgow. She was engaged for this voyage to convey Italian emigrants from Trieste, Naples, and other Italian ports to New York. When she left Naples there were 813 emigrants on board, of whom 661 were men, 85 women, and 67 children. Of the whole number 783 came from the southern provinces of Italy, while 21 were citizens of Trieste. The crew and officers numbered 50. Captain M'Keague was in command.

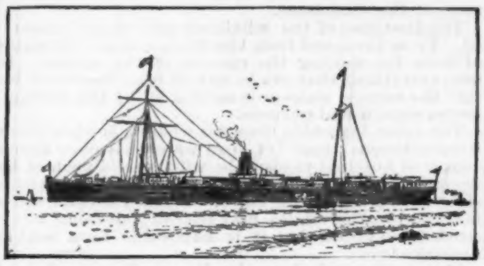
The vessel was seen before dark in the evening steaming toward the anchorage. When abreast of the ironclad Anson, flag-ship of Rear-Admiral Jones, of the Channel Squadron, lying at anchor off Ragged Staff, at the south end of the town, near the parade and public garden, the Utopia was seen to stagger as if unable to make headway against the strong current running out at the time. In a moment the fierce gale combined with this current swept the ill-fated vessel across the bows of the Anson, which is a twin-screw first-class armor-clad, with a formidable ram. This ram cut bodily into the steamer, and she then drifted before the wind and sea until the rapid inrush of water made her begin to settle down, which happened five minutes after the first shock.

Boats were at once lowered from the Anson and other vessels of the British squadron, as well as from the Swedish war ship Freya and the cable ship Amber, while the ironclads turned their electric search lights toward the wreck to assist the rescuers in their difficult task; for by this time the daylight was almost gone. One boat, the pinnace, of H. M. S. Immortalite, was dashed on a rock by the force of the sea, and two of her seamen were drowned. The sea was running so high that the boats could not approach the wreck with any hope of taking off those on board, and were compelled to lie to leeward, picking up the people as they were swept off the decks. As the Utopia's bows began to sink, those on board the wreck rushed forward, struggling with each other for life and fighting their way up the fore-rigging. Twenty minutes later the forecastle disappeared beneath the surface, carrying down the crowds of unfortunate beings who had not dared to jump off, and had failed to take refuge in the rigging.

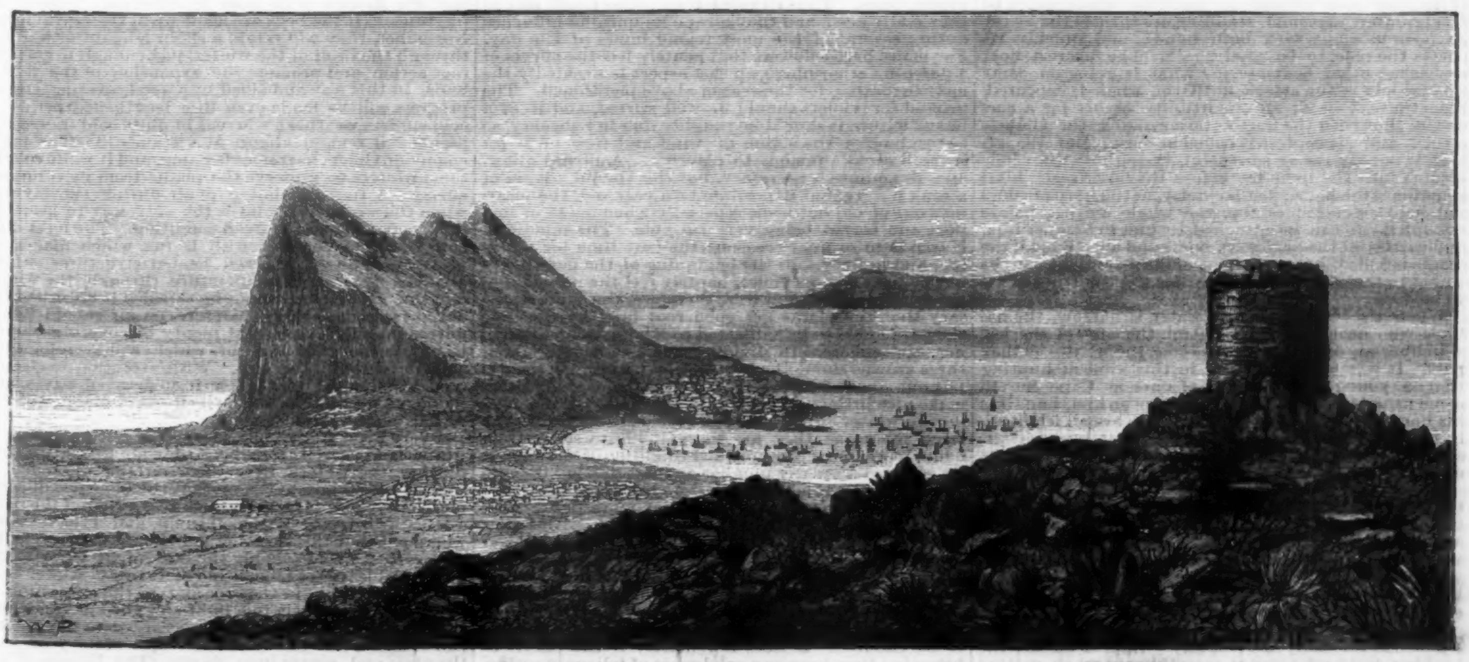
The wind and rain were so blinding that scarcely anything could be seen beyond a confused struggling mass of living beings mixed up with wreckage. Those who had succeeded in taking refuge in the main rigging were rescued several hours later, but so exhausted that they could not get into the boats, and it was necessary for the rescuers to clamber up the shrouds in order to pass the poor creatures down into the boats.

Twenty-four of the Utopia's crew were saved, including the captain, ship's doctor, two officers, one engineer and one steward. Of the passengers and emigrants only 292 were saved; there were seventeen passengers in addition to the 813 emigrants on board.

The Bay of Gibraltar is notoriously a bad harbor, affording no shelter from the most violent wind and sea. This lamentable disaster shows the great necessity for new inventions and appliances for saving life on ship board and also the need of improvements in vessels whereby they may be prevented from sinking. Our engravings and particulars are from the *Illustrated London News.*



THE UTOPIA, ANCHOR LINE STEAMSHIP.



VIEW OF GIBRALTAR FROM THE "QUEEN OF SPAIN'S CHAIR," SHOWING WHERE THE UTOPIA FOUNDERED.

WHALE CATCHING AT POINT BARROW.

By JOHN MURDOCH.

ALL through the latter part of the winter the seal hunters, who are every day tending their nets, along the shore from Cape Smyth to Point Barrow, have been watching and studying the ice. Running along nearly parallel to the shore and about a thousand yards off is a bar on which the water is not more than two or three fathoms deep. On this the heavy pack ice, coming in with the autumn gales, usually grounds, piling itself up into a wall of rugged masses of ice, while inshore the sea freezes over smooth and level. Outside of this is the rough pack, broken masses of ice piled up in irregular heaps like the craggy fragments on a frost-riven mountain top, but interspersed with undulating fields of ice, many seasons old, and thick enough to resist the pressure when the ice fields come together before the winds and currents. Occasionally, too, the grounding of heavy masses of ice—there are no true icebergs in this part of the Arctic Ocean—affords sheltered spaces where fields of "new ice" can form undisturbed by the movements of the pack.

Through January, February, and March these ice fields remain motionless, or are only crushed closer together and pressed harder upon the land by the prevailing westerly gales; but in April the pack gradually begins to loosen, and when the long-wished-for east wind blows, cracks open six or seven miles from the shore, extending often for miles, parallel to the land. These cracks or "leads," as they are called, seldom remain the same for many days, but open and close as the wind changes, now spreading clear of all obstructions for hundreds of yards or even for a mile in width, now filled with loose ice, floating with the current.

It is in these leads of open water that the whales work their way to their unknown breeding grounds in the northeast, passing by Point Barrow chiefly during the months of May and June, and it is during this season of migration that they are hunted by the Eskimos.

The chase of the whale is of great importance to these people. The capture of one of these monsters means meat in abundance; blubber for the lamps, and for trade with the Eskimos whom they meet in the summer; whalebone to purchase ammunition; tools and luxuries from the ships; and the choicest morsel that an Eskimo knows, the "black skin" or epidermis of the whale. Consequently, the successful whaleman is the best man in the village, and soon grows rich and influential.

But to return to the seal hunters and their observations of the ice. From long experience, the Eskimos are able to judge pretty accurately where the "leads" will first open in the spring, and, when they have concluded where the boats will be launched, they set to work to select the best path for dragging out the boats through the rough ice field. They soon make a regular beaten trail, winding in and out among the hummocks, taking advantage of all the smooth fields of ice that they can, and, from time to time as they pass back and forth from their seal nets, they chip off projecting corners of ice with their ice picks, and with the same implement widen out the narrow defiles in the road, and smooth off the roughest places. Men sometimes go out on purpose to work a few hours on the road, using ice picks or "whale spades" (something like a heavy broad chisel, mounted on a long pole, used for cutting the blubber off a whale), which they have obtained from the white men. It is a pretty rough path, however, at the best.

By the middle of April all the hunters have returned from the winter deer hunt, and the business of getting ready for whaling is taken seriously in hand. The frames of the great skin boats must be taken down from the scaffolds where they have rested all winter, and carefully overhauled and repaired, while every article of wood that will be used in whaling, from the timbers of the boat to the shafts of the spears and harpoons, must be scraped perfectly clean, in honor of the noble quarry. Gear must be looked to, and the skin covers for the boats repaired and soaked in the sea, through holes in the ice cut close to the shore, till they are soft enough to stretch over the framework.

Meanwhile, a careful watch is kept from the village cliff for the dark cloud to seaward which indicates open water; and if the much talked of east wind does not speedily begin to blow, the most skillful of the wizards or medicine men get out on the bluff, and with magic songs and beating of drums do their best to make it come.

It is not every man in the village who owns a *umiak* that fits it out for whaling, as it requires a good deal of property to procure the necessary outfit. About eight or ten boats from each village make up the usual fleet. The crews—eight or ten men to a boat—are made up during the winter.

The owner of the boat—who is always the captain and steersman—sometimes hires his crew outright, paying them with tobacco or cartridges or other goods, and sometimes allows them a share in the profits, but, I believe, always feeds them while the boat is "in commission." When enough men for a full crew cannot be secured, women and even half grown lads take their places in the boat. One man is selected for harpooner and posted in the bow, and usually another, amidships, has charge of a whaleman's bomb gun, for firing an explosive lance into the whale, for most of the rich Eskimo whalemen now own these guns.

Now, as to the instruments used for the capture of the whale. Instead of harpooning the whale, or "fastening" to him, as the white whalemen say, and keeping the end of the line fast in the boat, which the whale is made to drag about till the crew can manage to haul up and lance him to death, there is but a short line attached to each harpoon, to the end of which are fastened two floats made of whole sealskins, inflated, which are thrown overboard as soon as the harpoon is fixed in the whale. Each boat carries four or five harpoons, and several boats crowd round and endeavor to attach these floats to the whale every time he comes to the surface, until he can dive no longer, and lies upon the water ready for the death stroke. Some of the harpoons are regular whalemen's "irons," but they still always use their own ingenious harpoons, in which the head, made of bone or walrus ivory, with a point of stone or metal set into it, is alone fastened to the line, and is contrived so as to "unship" from the shaft as soon as it is thrust into the whale, and to turn at right angles to the line, like a toggle, under the skin. To kill the whale after he is harpooned, they used in old times long lances, with beautifully flaked flint heads, as broad as one's hand; but now they all have regular steel whale lances, and as I have said before, most of them own bomb guns.

Some of the boats are carried out over the ice to the place where they are to be launched before the "lead" opens, and, as soon as open water is reported by the scouts, all start. There is a great deal of ceremony and superstition connected with the whale fishery. The captain and harpooner of each boat wear special trappings, and streak their faces with black lead, as, indeed, is often done on festive occasions. Long before the time for whaling, all those who intend to command whaling boats during the coming season assemble, with all their gear, in the public room and hold a solemn ceremony, with drumming and singing, to insure good luck. Charms and amulets of many kinds are carried in the boats. They believe that the whales are

supernaturally sensitive. If the women should sew while the boats are out, or the men hammer on wood, the whales, they say, would leave the region in disgust.

Let us see, now, how the boats are carried out over the path I have described. The boat is firmly lashed on a flat sledge, to which a team of dogs is attached, while the men and women hold on to the sides of the boat, pushing and guiding. Hearing, one day in May, 1882, that one of the Cape Smyth boats was starting for the edge of the ice, two of us set out over the trail, and overtook the party about two miles from the shore, where they were resting, having sent the dogs ahead in charge of two women, with another sledge loaded with all sorts of gear—rifles, spears, and so on.

The party consisted of five men and two women. The captain of the boat and the harpooner wore on their heads fillets of the light colored skin of the mountain sheep, from which dangled on each side a little image of a whale, rudely flaked from rock crystal or jasper. The captain's head dress was fringed with the incisor teeth of the mountain sheep, and the harpooner had another stone whale on his breast.

One of the women was decorated with a stripe of black lead diagonally across her face. In the boat, for charms, were two wolves' skulls, the dried skin of a raven, a seal's vertebra, and several bunches of eagle's feathers.

They say the skin of the golden eagle—"the great bird"—or a bunch of hairs from the tip of the tail of a red fox, bring great luck. In the boat were also five or six inflated seal skins, which, when we came up, they were using for seats on the ice.

One of the women soon came back with the dogs, the seal skin floats were tossed into the boat, the dogs hitched up, and we started ahead, the woman leading the dogs, and the men shoving alongside. When we came up with the first sledge, the dogs were unhitched from the boat and sent ahead with a load of gear for another stage, and so on.

On smooth ice the boat travels easily and rapidly; but where it is broken it is hard shoving and rough scrambling for the men, while occasional stops have to be made to chisel out projecting pieces of ice and widen narrow places in the path. Then the dogs get tangled up from time to time, and have to be kicked apart, so that their progress on the whole is slow.

When they reach the open water the boat is launched and the gear put on board, and the sledges drawn up out of the way. Everything is put in readiness for chasing the whales, and the boats begin patrolling the open water. The harpoon, with the floats attached, rests in a crotch of ivory lashed to the bow of the boat, and everybody is on the alert. Sails and oars are never used in the boat when whaling, but the boat is propelled by paddles alone.

Thus they spend the months of May and June, eating and sleeping when they can, for the daylight now lasts through the twenty-four hours, occasionally hauling the boat up to the edge of the ice for a rest. Somebody, however, is always on the watch for whales or seals or ducks, which last now and then at this season pass by in thousands on their way to the north.

When the "leads" close, the boats are hauled up safely on the ice, and all hands come home till an east wind and "water sky" warn them of a fresh chance for whaling.

Let us suppose that there is good open water, and that a couple of boats are hauled up on the edge of the land floe, their crews resting and gossiping, perhaps waiting for the return of the women who have been sent home to the village for food. Suddenly a faint puffing sigh is heard, and a little puff of vapor is seen over toward the edge of the ice. It is a whale "blowing."

The men all spring to their feet and quickly run the boats off into the water, and scrambling on board, grasp their paddles and are off in the direction of the "blow." If they are lucky enough to reach the whale before he escapes, the harpooner, standing up, thrusts the heavy harpoon into him with both hands, and quickly recovers the pole, to be used again. The nearest boat rushes in; other boats, seeing what is going on, come up and join in the attack until the whale is captured. Sometimes, indeed, an opportunity occurs for a successful shot with the bomb gun as soon as the whale is struck, and the contest is ended at once. But the attack is not always so successful. Sometimes the whale escapes into the loose ice before the boats reach him; sometimes the harpooner is clumsy, or the harpoon does not hold. Sometimes, too, the whale escapes before enough floats can be attached to him to hamper him, and carries off the harpoons, floats and all. Even if the whale is killed, he sometimes sinks before he can be towed to the edge of the ice, where the "cutting in" is to be done.

When the "lead" of open water is narrow, the natives who own bomb guns patrol the edge of the ice, watching an opportunity to shoot the whales as they pass. It was when engaged in this kind of hunting that a young acquaintance of ours at Cape Smyth came near losing his life. A man near him, handling his bomb gun carelessly—the Eskimos are all frightfully reckless with fire arms—discharged it by accident, sending the bomb into the ice under his feet, where it exploded, shaking him up like a small earthquake.

When the whale is killed, it is towed, as I have said, to the edge of the solid floe, and the work of cutting him up begins. By long-established custom, universal among the Eskimos, the skin, blubber, and flesh of a whale belong to the whole community, no matter who killed it; but, at Point Barrow, the whalebone must be equally divided among all the boats that were in sight when the whale was killed.

They have none of the appliances used by civilized whalemen for easily and rapidly stripping off all the blubber, but hack away at everything in reach, getting off all they can before the carcass sinks. The news soon reaches the villages that a whale has been killed, and there are very few households that do not send a representative to the scene of action as speedily as they can, with sledges and dogs to bring away their share of the spoils. As may be supposed, there is a lively scramble round the carcass. Some on the ice, some crowding the boats, they cluster round the whale like flies round a honey pot. Leaning over the edge of the boats, careless of the water, they hack and cut and slash with whale spades and knives, each trying to get the most he can. So far as I have ever heard, this is a perfectly good-natured scramble, and no one ever thinks of stealing from another's pile on the ice. The blubber, meat, "blackskin," and whalebone are soon carried home to the village. The blubber is not tried out, but is packed away in bags made of whole seal skins, and, with the meat, is stowed away in little underground chambers, of which there are many in the villages.

The "blackskin" is eaten fresh, and is seldom if ever cooked. This curious dainty is the epidermis or cuticle of the whale. It is about an inch thick, and looks, for all the world, like black India rubber; it is not so tough, however. Civilized whalemen are nearly as fond of it as the Eskimos, but are not in the habit of eating it raw. When nicely fried in the fresh, sweet oil of the "try pots," when they are "boiling out" the blubber of a whale, for instance, it is very palatable, tasting much like fried pigs' feet. It is also good boiled and "soused" with vinegar and spices. The Eskimos are fond, too, of the tough white gum round the roots of the whalebone.

The jawbones of the whale are cut out and preserved. From these and from the ribs are sawed out strips of bone for shoeing the runners of the sledges. In fact, everything that can be cut off from the whale, before the carcass sinks or is carried off by the current, serves some useful purpose.

The most favorable time for whaling is when there is a continuous "lead" of open water, not more than a couple of hundred yards wide, with a solid pack of ice beyond it. Then the whales must pass up within sight or hearing of the boats. When the open water is very wide, the whales may pass at a distance unnoticed, or so far off that it is impossible for a boat to overtake them.

If there is much loose ice, the crafty animals take advantage of it, and come up to breathe at little holes among the floes where a boat cannot reach them.

As the season advances, the whales grow scarcer, and the whalemen relax their vigilance and pay more attention to the capture of seals, which they shoot through the head when they rise near the boat, securing them with light harpoons before they have time to sink. At this season, also, the whale boats sometimes capture walrus and white whales.

At length several days pass without a whale being seen, and one by one the crews give up looking for them and bring home their boats, until by the first of July the whaling is over for the year, the boats are all in, and everybody is preparing to leave the village for the summer excursions.—*Popular Science Monthly.*

DOUBLE VIOLETS.

THERE are few hardy flowers better worthy of good culture than the various fine forms of double violets. A bunch of the double Neapolitan or Marie Louise in the depth of winter is very acceptable. Blue flowers are always scarce at that time of year, and there is nothing that can equal the violet in its refreshing perfume. Success in violet culture, and more especially as regards the production of winter blooms, depends mainly on the culture that the plants get through the summer months. Allowing them to grow in thick beds or in shady positions will not do, for it is not enough that a free growth be made; the crowns must be exposed sufficiently to sun and air to allow of their becoming plump and well matured by the autumn.

Although a little shade from the hot summer sun is undoubtedly beneficial to violets, I would much rather grow them in full exposure to it than in such secluded positions as I have often seen chosen for this flower. With abundance of moisture at the roots and frequent overhead sprinklings in parching weather, the hot sunshine will not injure, but, on the contrary, will endow the crowns and foliage with a substance that is not obtainable in any other way. The best of all positions is undoubtedly that from which the sun passes away shortly after midday, and if such a place can be had, I would advise the various forms of double violet to be grown there. Thus situated they get as much sun as they really need, and they escape its burning influence during several of the most trying hours of the day. For many hardy flowers that acutely feel the effects of a parching atmosphere an east aspect is decidedly the most favorable, for the reason above mentioned. The ground for violets should be well stirred, and if of a heavy nature it should be roughly dug in February, so as to allow of the action of wind and frost on it for several weeks previous to planting. A liberal allowance of manure is necessary, but this should not be of a rank nature, but if possible be a year old, the clearings out of old hot beds, especially when made of manure and leaves, being very suitable. The middle of March is in ordinary seasons the best time for planting, and in light soils the beginning of the month will not be too early, as violets acutely feel the influence of parching weather, and it is, therefore, the more necessary that the plants get good root hold by the time they are liable to be subjected to a hot sun and parching atmosphere. In dividing the old stools, about three crowns should be left to each plant, and these if put out about 6 inches apart will with good attention make nice little specimens by the autumn. For blooming in winter in frames, I do not care to have very large plants, as they are more liable to suffer from damp by reason of the crowded condition of the foliage. By growing a greater number and not putting them in the frame too thickly, air can better circulate among the crowns, and naturally they get more light. It is not the number but the quality of the crowns that has to be considered in the individual plants. If, however, the plants are to remain to bloom in the open, it does not matter how large they are; indeed, I think the bigger the better, as the opening buds get more shelter from the foliage in the early days of spring, when biting winds and frosty nights are sure to have to be endured. It does not matter if the plants at blooming time become a solid mass of foliage in spring, so long as each one has ample space when making its growth and ripening its crowns. Red spider is the worst enemy that violets have, and sprinklings of soot round the plants are recommended to keep it off. I would, however, much rather rely on plenty of good food and moisture to keep it at bay. This insect always fights shy of well nourished foliage, and I doubt if ever violets are much troubled with it when under the influence of liberal culture. But the attention in watering must be continuous during the hot, dry weather that we generally get in the summer season. A few days' dryness at the roots with a burning sun acting on the foliage will suffice to bring on an attack of spider, and then it cannot be got rid of for that season at least. The great thing is to prevent its appearance, and this I am sure can be done in a general way. It must be remembered that growing violets in inclosed gardens is attended with rather more difficulty than in open fields where they are cultivated for market. It is not often that the plants are attacked by spider under field culture, owing to the greater amount of air they get as compared with what they can enjoy in the confined precincts of a garden. The atmosphere in a walled in garden becomes much more rarefied than where there is nothing to obstruct the summer breeze, and this parched air must be counteracted by means of copious waterings and daily overhead sprinklings in a dry, hot time.

In very hot weather, such as is often experienced in July and August, it is much better to water toward the close of the day, as thus the soil gets well moistened before a burning sun can again act upon it. Watering in the evenings is one way of economizing labor, as a much less quantity is required than if used at a period of the day when evaporation is rapid. For the same reason the plants should be well sprinkled when the heat of the sun has passed away from them, as thus the surface of the ground remains through the night in a moist condition.

A cool, grateful atmosphere, which wonderfully refreshes and strengthens, and fills the leaves with sap, and better enables them to withstand the desiccating influence of a parching summer's day, is created. Whenever double violets are grown it is of the highest importance that they get a good share of sun in early autumn. It is in September and the beginning of October that the plants finish their growth and that the ripening of the crown takes place.

The influence of the autumn sun in a very direct manner is absolutely necessary for plants that are to bloom early in the winter, for it may be taken for granted that all who shelter the plants in frames wish to begin gathering at as early a date as possible. The autumn warmth not only plumps up the crowns, but induces the formation of bloom buds much earlier than when the plants are in a great measure secluded from its influence, and it is these early buds that furnish the blooms that expand at a time when they are so valuable.

This is especially the case with the double kinds, which must have the crowns well matured, or the blooms will be lacking in size and the symmetry and doubleness that render them so beautiful. The fine white Comte de Brazza, for instance, unmistakably shows the effects of good or indifferent culture. The blooms that are produced by insufficiently fed and matured plants come semi-double and by no means pure in color. In fact, this double violet is not worth frame room unless it is thoroughly well cultivated. When at its highest point of development it is certainly one of the fairest hardy flowers we have.

In ordinary seasons double violets will give a supply of flowers through the winter if merely sheltered in frames and covered in frosty weather, but in a period of hard frost, such as we have lately experienced, the amount of blooms produced under such conditions will be small. What they require is a gentle stimulus to keep them moving when the outdoor temperature remains for some time at a low point. A very gentle bottom heat, such as is afforded by leaves with a little manure with them, will give this. The best lot of double Marie Louise violets I ever saw were grown in this way, the blooms being remarkably large and excellent in color.

If a bed of this description is made up in the latter end of October, it will retain enough warmth through the winter to gently stimulate root action, and this is all that is needful. Anything approaching a forcing temperature must be avoided, for violets are impatient of artificial warmth (unless it is of the mildest description), which causes the leaves to become drawn and the flowers to be poor in color and deficient in fragrance. If the beds are made up in the beginning of November, they will retain a slight amount of warmth through the dead of the winter, just enough to keep up root action and promote the expansion of the flower buds. In this way and aided by a good covering, steady progress will be made even in a lengthened period of cold sunless weather; whereas in quite cold frames the plants will remain almost at a standstill. The great enemy of violets in frames is damp, and it is difficult in some winters to preserve the plants from its injurious effects. A free circulation of air during the daytime when the weather is mild is the only way to keep the foliage and blooms in good condition. The most difficult thing to contend with is fog, which makes its presence felt even in well heated structures, which are kept at an even temperature through the winter months. When fog cannot be expelled it must be kept out as far as possible; therefore, no air should be admitted on misty days, and plenty of covering should be put on the glass at night, which will keep fog from entering through the laps. With attention to cleanliness, keeping the plants free from decayed leaves, and judicious ventilation, the evil effects of damp will not be felt to any serious extent.

A very good and simple method of getting violets in winter is to grow them where they are to remain, just putting the frames over them on the approach of winter. It stands to reason that the blooms will come more freely and plentifully in this way than if the roots are disturbed late in the autumn, and I have often wondered that this easy method should not more often be resorted to. Probably the best of all ways to get good double violet blooms in the depth of winter is to pot up the plants in October and at the beginning of November; put them in a light airy glass house, where they get the treatment that is accorded to the general run of cool-house plants at that season of the year, near the glass and secure from damp. The blooms of the double Neapolitan, Marie Louise, and Comte de Brazza come very fine indeed. But the best of all the doubles in my opinion is the Parma, which is compact of growth and very free flowering. I have always got more flowers from it than from any other double variety. One advantage of growing violets in pots is that they can be employed in the house, and every one appreciates a nice plant with fresh healthy foliage and a dozen handsome fragrant flowers. I have invariably found that violets grown in this way are more highly valued for indoor decoration in the winter season than many other things that demand a lot of trouble and

considerable expense to bring into bloom at that time of year.—J. C. B.

Violets being universal favorites, perhaps a few notes on their cultivation as practiced here—differing as it does somewhat from the orthodox mode, on account of what may be called adverse conditions to their free growth, or soil being hot and stony—may be acceptable. I will briefly treat on the doubles first, these being grown here in greater numbers than singles and more admired, notably Marie Louise. In the kitchen garden, an open quarter which has been occupied during the summer with crops that had received good cultivation and liberal treatment is selected in the autumn when vacant. This is bastard dug and left as rough as possible until the middle of March or beginning of April, according to the state of the weather. When in a condition to work freely, it is lightly forked over, at the same time adding a liberal dressing of manure, afterward making the soil firm and level. I then look over the stock of plants in the pits in which they were wintered, and select well rooted, strong runners, which by this time have formed solid crowns, quite sturdy plants in miniature. Should an insufficient number of the kind of runners recommended be not forthcoming, recourse might with advantage be had to the division of the old plants, selecting the freshest and strongest crowns, generally found on the outside of the clumps. I am not much in favor of cuttings, only as a means to the more rapid increase of the stock. These are planted carefully with a trowel, 9 inches apart each way over the whole ground, making all firm as we go along. In a short time, say a month or so, the plants commence rooting freely in their fresh quarters, but make little top growth. The ground is mulched, completely burying the crowns, leaves, and all with leaf mould or any light material at hand, through which as growth progresses the leaves easily grow. I consider mulching, at this stage, very important, keeping, as it does, all clean and moist until a strong root hold, able to meet and respond to the call for the abundant feeding necessary to develop to the full extent the leaves and blooms during later growth, is established. To this, at least, I chiefly attribute the splendid growth of leaf and bloom we generally get here. As growth appears through this mulching, when time and means permit, a thorough soaking of diluted house sewage is occasionally given, with during showery weather a sprinkling of some artificial manure, as I contend that upon the ability of the plant to take up and utilize summer feeding mainly depend the quality and quantity of autumn and winter bloom. During the growing season the long straggling runners are cut out, leaving the close at home ones for winter bloom and stock. Careful hoeing and weeding complete the summer's routine of their cultivation.

In October it becomes necessary to lift and remove to the winter quarters—structures to which abundance of light and air has access. Ours are sunk pits, with a foot in height of concrete above the ground level, on which the lights are placed—rather primitive structures perhaps; nevertheless well suited for the purpose here, for being so low, the lights are not so liable to be blown away by the winter's storms, and the plants are easily protected during severe weather. In these the plants—now fine clumps bristling with blooms and buds—are placed, in rather light soil and about six inches from the glass, and as close together as the bulky roots admit. The whole is then given a soaking of clear water to wash flowers and leaves and settle the soil among the roots.

For a week or two after removal, a diligent picking of any leaves that damp has attacked is done, keeping off the lights, except in very wet or severe weather. Beyond this, an occasional watering when dry and a syringing overhead at times to assist the blooms to open more kindly during unfavorable weather, and so keep red spider at bay, are about all the winter treatment given. I would here like to give a word of warning as to watering during the winter season, and would strongly advise this being done with clear water, or if liquid is given, it should be very weak, or the newly expanded blooms will smell of whatever manure water is used. The foregoing notes apply chiefly to the cultivation of Marie Louise and the more delicate and weaker growing doubles. Singles and strong growers require more space between the plants and not quite such a rich larder, but runners of these ought also to be planted annually. With us, singles under glass are a comparative failure, but do well out of doors, producing a few blooms during the winter and abundance in the spring, with plenty of leaves at all times—most useful for bunching the doubles. I only grow four varieties—three doubles and one single. Marie Louise, unequaled in all points, and invaluable for supplying our heavy and constant demand. Comte de Brazza is the best white, being free in growth and flowering, but, strictly speaking, only a spring bloomer. Victoria produces magnificent blooms of good color—dark blue—in spring only; a very weak grower here, but grown in limited quantity for the sake of variety and the few extraordinary blossoms. Odoratissima is our only single.

To those who may be similarly situated in the matter of unsuitable soil, etc., I would strongly recommend them to plant early and annually on well cultivated ground in an open, sunny position, thus insuring well ripened crowns. Treat liberally, mulch early and thoroughly; cut close long straggling runners, but allow reasonable latitude to the short ones, as they will be useful hereafter for bloom and stock. By so doing success can reasonably be expected.—J. R., Merioneth.—*The Garden.*

THE SILVER MAPLE.

THE silver maple is one of the largest and most beautiful trees in a genus peculiar for the beauty of its species. To many people, perhaps, who know it only as a shade or street tree, the silver maple does not always appear to be a handsome or desirable tree. Planted, as it has been very generally, for such purposes, it often has a weak and overgrown appearance, as if it had outgrown its strength; the branches are brittle and easily broken by wind and snow, the foliage is often thin, and the leaves fall early. This is the silver maple to people who know it in towns only and who see a tree in the wrong place, and where all the conditions are unfavorable to the development of its beauty. There are trees, like the scarlet maple, the river birch and our Eastern larch, which seem to flourish as well when they are placed in unnatural conditions of soil and surroundings as in the situations in which they grow naturally, and which thrive as well on a hillside as in their native swamps. The silver maple is more fastidious. Unfortunately, it grows very rapidly, and even in unfavorable situations few trees will attain a greater height or a thicker stem in the first forty or fifty years of their existence. It is this rapidity of growth that has made the silver maple a favorite with people who are in a hurry to obtain immediate effects, and do not care to look very far ahead; and at one time it was planted in the Northern States, especially in cities and their suburbs, in immense numbers, without much regard being paid to the fitness of the position selected for it.

The silver maple is an inhabitant of low, sandy river banks, and it is on river banks only or in low meadows that it displays its beauty; and the lover of trees, if he would see it at its best and would realize what the silver maple becomes when all conditions favor it, should float down one of the large streams which flow into the tributaries of the lower Ohio. Here may be seen the river forests of the Mississippi basin in their full richness and beauty, and maple trees unequaled in majesty and grace by those of any part of the world. In the rich alluvial soil which forms the low banks of such streams, the silver maple rises sometimes to the height of a hundred and twenty feet, with a trunk three or four feet in diameter. Ten or fifteen feet from the ground this divides usually into three or four stout, upright, secondary stems, which are destitute of branches for a considerable height above the division of the main trunk and then ultimately separate into many slender branches with slender, pendulous branchlets, the whole forming a wide and majestic head. The bark of the trunk on the old trees is bright reddish brown, more or less furrowed by deep longitudinal fissures, while the surface separates easily into large thin scales. On trunks of young trees and on the branches of old ones the bark is quite smooth and light gray, faintly tinged with red. The young branchlets are bright chestnut brown, with a smooth and lustrous surface, and are marked with large, pale spots. The winter buds are rather small and are covered with bright red, imbricated scales, with a conspicuous fringe of pale hairs on the margins. The ample leaves are often six or seven inches in length, rather less in width, and are deeply five-lobed by narrow sinuses, with acute, irregularly toothed divisions, the middle division being often larger than the others and somewhat lobed. They are thin and membranaceous, and borne on long, slender, bright red petioles they dance with the slightest breath of wind, displaying in turn the bright and cheerful green of their upper surface and the silvery whiteness which clothes their lower surface. In autumn they turn pale yellow.

The flowers of the silver maple, like those of our red maple, appear late in the winter, or in very early spring, long before the leaves; they are produced in sessile axillary fascicles on the shoots of the previous year, or on short spur-like branchlets developed the year before from the wood of the preceding season. The sterile and fertile flowers appear in separate clusters, sometimes together on the same tree, but more frequently on different trees. The buds from which they open are aggregated into compact clusters, and are covered with thick red and green scales fringed on the margin with long rusty brown hairs. The flowers are greenish yellow and have no petals; the calyx, which is five-lobed, is slightly hairy on the outer surface and is long and narrow in the sterile, and short and broad in the fertile flower. There are from three to seven stamens; in the sterile flowers the slender filaments strengthen until they become two or three times as long as the calyx, when the pollen is discharged from the anthers, while in the fertile flowers the filaments do not lengthen after the bud opens, and the anthers wither or fall off without opening. The ovary, which is reduced to a minute point in the staminate flower, is covered with hairs. It is possible that perfect flowers with a fully developed ovary and stamens may be found, as such is the usual order of nature in the case of flowers which have become generally unisexual by the abortion of one of their organs, but if such flowers exist they are uncommon. The ovary of the fertile flower develops into a large fruit with long broad wings, which are sometimes nearly straight and sometimes shaped like a scythe. The fruit ripens at the end of a few weeks after the flowering period, if it is not destroyed by spring frosts, as is often the case, for the silver maple, enticed into opening its flower buds by the succession of a few warm days in late winter, pays for its temerity with the loss of its fruit. Sometimes only one of the two samara, of which the fruit of the maple is made up, is developed, and it is not an uncommon thing to find a tree producing one-sided fruit, the second and undeveloped ovary appearing as a rudiment at its base. The seed of the silver maple, if it happens to fall on moist open ground, germinates immediately, and produces plants which grow sometimes to be nearly a foot high before winter and strong enough to have in their favor the chances of surviving the hardships to which all seedling plants are subjected. In this habit of early flowering and quick development of the seed of our silver and scarlet maples, a habit which is peculiar to them, may be found, perhaps, a wise provision for their perpetuation. These two trees grow on low river banks or in swamps—situations which are often submerged for a considerable part of every year, especially in winter and early spring. If the seeds of these trees ripened in the autumn, like the seeds of other maples, and did not germinate until the following spring, they would run a serious risk of being water soaked and of icing their vitality. Now, however, they reach the ground at the very best period of the whole year for quick germination. The water has receded from about the trees, leaving a moist open surface, warm but not yet baked by the sun of early summer. It is a question which we do not pretend to answer, whether these trees acquired this habit of ripening their seeds early in the summer in order to maintain their existence in the low situations where they grow, or whether, the habit having been previously acquired, they were gradually driven to the swamps because their seeds were unable to germinate on the drier uplands at the period of the year when it reached the ground and could only germinate in soil from which the water had recently receded, and was, therefore, full of moisture.

The silver maple is widely distributed in eastern America; it is found in the north from the valley of the St. John's River, in New Brunswick, to southern Ontario, and extends southward to western Florida and westward to eastern Dakota, Nebraska, Kansas and the Indian Territory. It is not found very near the Atlantic coast or in the high Appalachian Mountains. It is very common, however, west of the mountains throughout the Mississippi Valley, where it is one of the largest and most generally distributed of the river trees.

The silver maple is often called also the soft maple, a name which it owes, probably, to the brittleness of its slender branches, for the wood of this tree is not soft, but hard, strong, close grained and valuable, furnishing excellent material for the floors of houses and for furniture. It was the Swedish traveler Kalm who first distinguished the silver maple, and sent it to his master, Linnæus, who named it *Acer saccharinum*, a name which has unfortunately become more associated with another of our maples than with the tree to which it properly belongs.

The silver maple has been cultivated in Europe since 1725, and flourishes there not so well, perhaps, as on the banks of its native streams, but better than many of our American trees; and in American and European nurseries a number of varieties with more or less cut or divided leaves, or with leaves blotched with yellow, or with white, or with more or less pendulous branches, have appeared. None of these varieties, however, are very distinct or in any way materially better or more beautiful than the wild tree.

The silver maple is a valuable tree in ornamental planting only when it can be placed in deep, rich and moist meadow land or by the banks of streams or lakes over which it can spread its long and graceful branches and display the beauty of its brilliant foliage.—*Garden and Forest.*

CONCENTRATED ESSENTIAL OILS OF LEMONS, LIMES, ETC.*

By Arthur A. Barrett.

In bringing under your notice this evening the subject of concentrated essential oils, I think it will be well to pass in rapid review the state of our knowledge of essential oils, and more particularly its recent development.

As the subject is rather an extensive one, I have limited myself to the oils of lemons and limes. These oils are of considerable commercial importance, and though our friends from Widnes and St. Helens whom I see here to-night may think the subject far less interesting than sulphureted hydrogen and hydrochloric acid, and beneath their notice, yet the total value imported of the two oils together is very considerable.

Until quite recently it was laid down in our manuals of chemistry that many essential oils were identical in composition with oil of turpentine and chemically indistinguishable from it. Gmelin, without attempting completeness, enumerates no fewer than 28 terpenes, all of which are represented as being compounds with the formula $C_{10}H_{16}$, yet differing from one another in some way not explained.

When the benzene nucleus theory came into vogue and the laws of isomerism began to be understood, these differences were attributed to isomerism or the position of the grouping in the molecule, but it was soon perceived that if this were so, the number of isomers was still strictly limited, and attempts were made to reduce Gmelin's 28 to more modest proportions.

One of the first of the modern school of chemists to investigate the subject was Dr. Tilden of Birmingham. He succeeded in proving the identity of several of the terpenes, and was the first to point out that in the cases of oils of lemon and orange the terpenes did not contain much flavor. Owing, however, to the high temperature employed in his method of fractionation, he unfortunately or fortunately seems to have come to wrong conclusions as to the properties of the high boiling portions of the oil.

Dr. Tilden was the first to point out that in the case of oil of lemon the terpene does not contain much flavor. My object to-night is to prove to you that it really contains none. Dr. Tilden says: "Of the various constituents of volatile oils, the terpenes which are present in so many of them contribute less than any other to the peculiar odor of the oil."

In the case of oil of lemon he finds in addition to terpenes, a compound ether, $C_{10}H_{17}(C_2H_3O)O$, which is decomposed by heat into a hydrocarbon ($C_{10}H_{16}$) and acetic acid. I have not been able to obtain any evidence of the presence of this body, and coupling this fact with the guarded words of Dr. Tilden, I have come to the conclusion that it does not exist.

About the same time—1877-79—that Dr. Tilden was at work, Dr. Gladstone and Mr Kingzett made independent researches which confirmed Dr. Tilden's results as to the identity of the terpenes.

I have great pleasure in knowing that our countrymen led the way in the study of this important class of bodies, as at the present moment the classic research of Professor Wallach, professor of pharmacy at the University of Bonn, threatens to obscure entirely all that had previously been done.

Professor Wallach has devoted several years to the study of the terpenes, and his papers published in the "Annalen" relate the particulars of what may be described as a model research.

Without going into detail, I may say that generally Professor Wallach has succeeded in classifying the terpenes and bringing them into some sort of order. At the same time a large number which were thought to be distinct from one another have been proved to be identical.

Thus—

Cinene, the terpene	of oil of	worm seed
Cajeputene, "	"	cajeput
Hesperidene, "	"	orange peel
Citrene, one of the	"	lemon peel
Carvene, "	"	caraway
Menthene "	"	peppermint

are all identical and may be termed limonene. This terpene is also present in oil of camphor, oil of dill seed, oil of erigeron, oil of pine needles. Naturally, it

* From a paper read recently before the Society of Chemical Industry, Liverpool.

having been proved that the terpenes of lemon, caraway, and peppermint were identical, it at once became probable that in the same way as the flavor of oil of caraway is due to carvol, peppermint to menthol and menthon, so oil of lemon would prove to owe its flavor to some quasi impurity of the terpene.

Chemists were not long in trying to isolate this, the characteristic constituent, and it is now possible to prepare it in an almost pure form. I am pleased to be able to lay before the meeting a sample of this body and also the body to which oil of limes owes its characteristic flavor. I have also samples of the terpenes from which these bodies have been separated.

If oil of lemon be distilled in a glass retort in the ordinary way over a gas burner or otherwise, and the distillation is not carried too far, the distillate will be found to be weaker than the original oil, while the residue in the retort is considerably stronger. This is the body, prepared in a more scientific way and completely freed from terpene, which I designate concentrated oil, and samples of which I now exhibit.

I term it concentrated oil, because up to the present I cannot say with certainty what is its exact chemical composition. I hope to continue my investigations in this direction, and will meanwhile give you particulars of its properties.

Concentrated oil of lemon is neutral to litmus paper and has a pure lemon smell. It has a specific gravity of 901, never less than 900, at 15° C., and boils at 220° to 240° C., at which temperature it is partly decomposed.

Treated with bisulphite of soda it forms a magma and it is probably an aldehyde. With oxidizing agents it yields a fatty acid. Warmed with metallic sodium it yields a brown mass.

A similar article to the one I am now showing was examined by Dr. Schweissinger, who published his results in the Pharmacoutische Centralhalle, and my results agree with his.

The terpene from which the concentrated oil has been separated retains a pleasant but weak odor, but is practically free from all flavor of lemon. The specific gravity is 0·850. It boils between 168° and 178°, and consists of pinene and limonene.

Concentrated oil of limes made from the fruit has not been previously prepared that I am aware of, though some work has been done in this direction by Mr. Francis Watt, chemist to the Montserrat Company. The oil which he examined and reported on to the Chemical Society of London was made from the leaves and young fruit of the lime fruit tree, *Limus limetta*. This is not a commercial article.

In this oil of lime leaves, Mr. Watt found a body boiling between 220° and 230° C., which he believes to be methylnonyl-ketone, $CH_3COC_9H_{19}$. This is possibly the same body which I am about to describe as concentrated oil of limes, made from the fruit.

Concentrated oil of limes as prepared by myself has a specific gravity of 920 to 923, is neutral to litmus paper and boils from 220° to 230° C. With bisulphite of soda it forms a magma. Warmed with metallic sodium, it comes very viscid, but not solid. With oxidizing agents it forms a fatty acid.

The terpene from which the concentrated oil has been separated contains a small quantity of a substance with a low boiling point, having a very objectionable smell, to which in a considerable degree the rankness of oil of limes is due. This is present in such small quantities that at present I have not been able to isolate it. The terpene when freed from this impurity has very similar properties to the terpene from oil of lemon. It retains a slight smell of limes, but is quite free from flavor. It boils at 176° to 180° C., and is probably nearly pure citrene.

Now as to the practical application.

Up to the present time the chief employment of these concentrated oils has been in the manufacture of liquors and sirups, and the improved flavor obtained by the absence of the objectionable greasiness of the terpene makes them specially suitable for this purpose. A great point in their use is that they dissolve at once to a clear solution, and in spirit of a much lower strength than has to be employed when using crude oils. In this country, where the high duty on alcohol makes spirit such a very expensive article, this is a very important advantage.

In using them it is a good plan to dilute the oils to about the same strength as the oils from which they have been prepared with strong spirit, say 56 per cent. over proof; 1 part to 29 parts of spirit. You then have a solution which can be used in old receipts without making any calculation. It is rather remarkable that this solution in strong spirit has but little smell, the odor being only developed when the solution is largely diluted with water. The same thing is noticed, but to a smaller extent, when ordinary oil of lemon is dissolved in spirit, but the terpene seems to aid the diffusibility of the odorous principle.

Having diluted the concentrated oil with strong spirit to the strength of the ordinary oils, they may be further diluted with weaker spirit or added to the bulk of the cordial or liquor to be flavored.

The following table represents in a convenient form the solubility of the concentrated oils in various strengths of spirit:

Strength of Spirit.	Concentrated Oil of Lemon.	Concentrated Oil of Limes.
Rectified Spirit, sp. gr. 838	All proportions.	All proportions.
900	1 in 150	1 in 160
905	1 in 300	1 in 400
920	1 in 500	1 in 600
935	1 in 3,000	1 in 4,000

In confectionery uses have been found where the employment of concentrated oils is advantageous, and in articles where sugar or other dry powders are required to be flavored with lemon, and where oxidation is very rapid, the use of concentrated oil is an improvement. As the boiling point is so much higher than that of the crude oils, it may be advantageous to use concentrated oils where high temperatures are employed in this department.

I do not doubt also that in perfumery concentrated oil of lemon will to a large extent displace the crude oil, owing, among other reasons, to the fact that it is quite free from the fixed fat and resin which is contained in ordinary oil.

How nasty this residue is, contaminated as it is with dirt from the hands of the none too cleanly Italian workmen who prepare the oil, you will have an opportunity of judging for yourselves from the sample on the table.

For perfumery I have to acknowledge one disadvantage, and that is that in an alcoholic solution the odor is only developed when the spirit has entirely evaporated; when the perfume has evaporated on the handkerchief, the purity of the odor becomes evident. I think that by using a small quantity of terpene in addition to the concentrated oil this difficulty would be got over, and the advantages of being able to use a weak spirit retained.

An important point is: Do the concentrated oils keep? The answer is: Yes, much better than the crude oils. They should be carefully stored, and the same precautions taken as are usual with valuable essences, and they keep well. It is quite impossible for them to become "turpentiney," as they contain no terpene, $C_{10}H_{16}$, whatever.

The deterioration of oil of lemon by keeping is due, in my opinion, to the production of nascent peroxide of hydrogen by the action of air and moisture on the limonene and pinene. This reaction, which has been so ably utilized by Mr. Kingzett in his Sanitas process, is highly objectionable in oil of lemon, rapidly destroying the aldehyde to which the flavor is due.

The best method therefore of preserving the flavoring principle of oil of lemon is to remove the terpene. It can then be kept, if excluded from the air, in the same way as any other aldehyde.

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